PRECIOUS STONES AND GEMS.

(6TH EDITION.)

WORKS BY THE AUTHOR.

"*Pearls and Pearling Life;*"

"*The Great Diamonds of the World;*"

"*Gold; its Legal Regulations and Standards,*" *&c. &c.*

"*Conditions of Nations,*"
by G. F. Kolb,
with Original Notes and Information
by Edwin W. Streeter, F.R.G.S.

"*Pocket Manual of Precious and Semi-Precious Stones,*"
Their Composition, Crystallization, Hardness and
Specific Gravity.

The Pearl Fisheries of the Persian Gulf.

Yours truly
Edwin W. Streeter

PRECIOUS STONES

AND

GEMS,

THEIR HISTORY, SOURCES AND CHARACTERISTICS.

BY

EDWIN W. STREETER,

F.R.G.S., M.A.I.

Gold Medallist of the Royal Order of [illegible]

[illegible] of the King of the Belgians.

Illustrated
WITH COLOURED PLATES.

SIXTH EDITION,

[illegible] UP TO DATE

LONDON:
GEORGE BELL & SONS, YORK STREET,
COVENT GARDEN.

1898.

PRECIOUS STONES

AND

GEMS,

THEIR HISTORY, SOURCES AND CHARACTERISTICS.

BY

EDWIN W. illiam STREETER,

F.R.G.S., M.A.I.

Gold Medallist of the Royal Order of Frederic:
Holder of a Gold Medal from H.M. the King of the Belgians.

Illustrated
WITH COLOURED PLATES.

SIXTH EDITION,

REVISED AND LARGELY RE-WRITTEN, UP TO DATE.

LONDON:
GEORGE BELL & SONS, YORK STREET
COVENT GARDEN.

1898.

"I hold every man a debtor to his profeſſion, from the which as men of courſe doe ſeeke to receive countenance and profit, ſo ought they of duty to endevour themſelves by way of amends, to be a helpe and ornament thereunto. This is performed in ſome degree by the honeſt and liberall practice of a profeſſion, when men ſhall carry a reſpect not to deſcend into any courſe that is corrupt and unworthy thereof, and preſerve themſelves free from the abuſes wherewith the ſame profeſſion is noted to bee infected; but more is this performed if a man bee able to viſite and ſtrengthen the roots and foundations of the ſame itſelf, thereby not only gracing it in reputation and dignity, but alſo amplifying it in perfection and ſubſtance."

LORD BACON.

CONTENTS.

SECTION II.—DIAMONDS.

SECTION III.—COLOURED STONES.

SECTION IV.—SEMI-PRECIOUS STONES.

LIST OF ILLUSTRATIONS.

PREFACE.

MANY works have been written on the fascinating subject of PRECIOUS STONES AND GEMS. Authorities on authorities, from remote antiquity to our own day, have been cited as to their value, their uses, and their properties. But, notwithstanding all that has been written, I have arrived at the deliberate conviction, that, as a merchant and dealer engaged for over fifty years in the purchase and sale of gems, as well as in their cutting and setting, I might serviceably offer to the Public much information regarding the nature, the sources, mining, cutting, testing, and value of these stones. A practical and popular guide to those who have an interest in ascertaining the genuineness and value of Precious Stones cannot fail to be generally useful.

As an illustration of the difficulties of the subject, it may be stated that Prof. A. H. Church, in a lecture delivered before the Society of Arts on April 6th, 1881, pointed out a number of errors in the identification of a collection of Precious Stones which had been exhibited for years at the South Kensington Museum, although the official description of these stones had been confided to a well-known professor in mineralogy and expert in gems. I have reason to believe that other collections, on the Continent, if not in this country, contain many specimens of Precious Stones erroneously named.

In the division of family jewels much injustice is often done by persons incompetent to form a correct opinion of their values. A study of this work may serve to demonstrate the difficulty of an accurate discrimination. In all cases, whether for valuation or for probate, it would be wise to submit the jewels to a practised judge.

A lady had bequeathed to her some family jewels, consisting of a Sapphire and Diamond suite. As they had passed probate several times, and been valued by one of the first jewellers of the day, there was no doubt in the mind of the legatee of the genuineness of the Sapphires. On being applied to in relation to their value, I had the unpleasant duty of pronouncing the "Sapphires" to be only paste. Had they been genuine they would have realised from £30,000 to £40,000.

A gem should be a real possession, capable of affording pleasure to the wearer and the spectator, and, with fair usage, retaining an intrinsic and marketable value, undiminished by lapse of time, and, if fine, rather increasing in value than otherwise. I have sometimes seen in wear gems so scratched that their lustre has been seriously impaired, and a suspicion was thus excited in the minds of wearers and friends that there was a defect in the hardness of the stones, and consequently of their genuineness. If mounted stones are carelessly kept together and allowed to rub against each other, the Diamonds will inevitably scratch all the other stones, and thus disfigure them. It may be worth while to point out that a small sum expended in re-polishing such stones would restore their original lustre, revive the pleasure derived from the possession of them, and prevent the risk of their being sold by executors as paste or imitation jewellery.

In determining the value of gems, it must be borne in mind that a perfect stone is never met with; and that probably not even ten per cent. of the stones which are brought into commerce are really of fine quality.

Much study and attention will be required to attain a thorough knowledge of the properties and appearance of gems; but the subject is to most persons of culture one of singular interest, and with the tests mentioned in the Appendix (p. 309), a little study will generally enable the observer to distinguish the true from the false.

With objects such as those referred to above, I am publishing the present volume, which is the sixth edition of the original work; and I hope that in the revised form, which it now presents, it may be of service to those who have occasion to handle Precious Stones as a matter of business, as well as to the wearers of these beautiful objects.

It must be borne in mind that this book is not intended to be a strictly scientific treatise, but rather a practical work for those who, whether in the trade or among the Public at large, desire to obtain some knowledge of the general characteristics of Diamonds and other Precious Stones and Gems.

In conclusion, I trust that the Goldsmiths' Company, as fathers of the trade, will ere long throw open their fine suite of rooms in Foster Lane, and will not only establish a comprehensive library of books bearing on the study of jewellery, but by giving gratuitous Lectures on Precious Stones and Precious Metals, will offer that aid to the younger members of our trade, which is necessary for a proper understanding of their daily business. This Company have already done something, but we must look to

them for more aid, by affording favourable opportunities for exhibitions of fine art jewellery, and by awarding prizes, similar to those offered by the Turners' Company. This would give an impetus to study to those engaged in jewellery-work, and would enable the Public to obtain a more accurate knowledge of, and to take a deeper interest in, a subject which has hitherto remained the property of an exclusive few.

The legacies bequeathed to the Goldsmiths' Company by the famous goldsmiths and jewellers of the 15th, 16th, and 17th centuries, which have since increased in value to an extent almost inconceivable, without doubt were intended for some such purposes as those to which I have referred. I find that so early as 1415, a celebrated goldsmith, Sir Drugo Barentine, who was Lord Mayor of London in 1398, and again in 1408, gave "faire lands" to this Company. At the present day, when so much public attention is being devoted to the spread of technical education, it behoves us to see that the young goldsmith and jeweller is not neglected, and that the foreigner may not take his place in the production of art work, and in the mounting and setting of gems.

The early editions of this work contained a chapter on "Celebrated Diamonds," but that portion has been omitted in recent issues, in consequence of my having written a special work on the subject. In 1882 I published a volume of some 320 pages under the title of "The Great Diamonds of the World; their History and Romance." This work, which was most favourably received by the press, is now out of print.

In the earlier editions of my "Precious Stones" there was also a chapter on "Pearls." Some years ago I was

induced to send my two sons on a visit to the various Pearl fisheries of the world. The information which I received from them was of so interesting a character, that my attention was forcibly directed to the entire subject of Pearls, and I soon accumulated far too much matter for introduction into a general volume on Precious Stones. Under these circumstances I set myself the task of writing a separate work, devoted entirely to Pearls. This appeared in 1886, under the title of "Pearls and Pearling Life;" and was so well received as to be at present out of print.

It may be noted that the present work refers only to Nature's Gems, and does not therefore deal with artificial gems, except in so far as they may throw light on the probable operations of Nature.

Stimulated by the marked encouragement which my labours on the subject of Precious Stones, Gems, and Pearls have received, I have endeavoured to make the volume in its present form still more worthy of its popularity; and with this view, have subjected the work to a searching revision.

Thus improved, the present (the sixth) edition is sent forth in the conscientious belief that it contains an amount of information on Precious Stones and Gems—partly scientific and partly practical—not to be found in any other work.

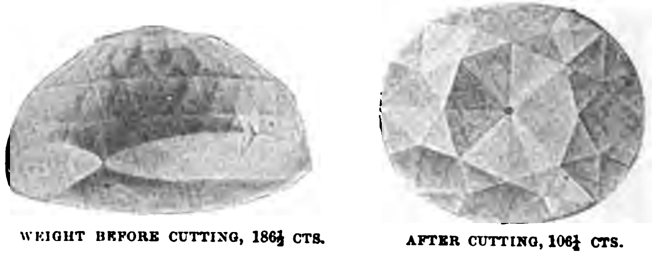
I am pleased to acknowledge the valuable aid which I have received from Mr. F. W. Rudler, Curator of the Museum of Practical Geology, in Jermyn Street, whose mineralogical knowledge has always been cheerfully placed at my service when difficulties of a scientific character have arisen. I am also under obligation to Sir William Crookes, F.R.S., for scientific advice, and to Mr. North for his chapter on the modern system of round diamond-cutting;

while I am likewise indebted to Mr. Atlay, the manager, and Mr. Morgan, the engineer, at the Burma Ruby Mines, for local information, as well as to Mr. Plummer, of Sydney, who has kept me informed with regard to new discoveries of Precious stones in Australia

Since the sheets of this work have been printed off, considerable excitement has been aroused by the occurrence of Diamonds in a conglomerate, and in gravels, at Nullagine, in the Pilbarra gold-fields, North-west Australia, latitude 21° S., longitude 120° E. But it remains to be seen whether the Precious Stones exist there in such quantity, and of such quality as to render their working a remunerative industry. This, in my opinion, is very problematical, whilst the production of South Africa shows no diminution.

London,

December, 1898.



WEIGHT BEFORE CUTTING, 186½ CTS. AFTER CUTTING, 106¼ CTS.

THE "KOH-I-NUR" BEFORE AND AFTER CUTTING.

SECTION I.

PRECIOUS STONES IN GENERAL.

CHAPTER I.

DEFINITION OF THE TERM PRECIOUS STONE OR GEM.

AMONG the infinitely diversified products of Inorganic Nature, there are certain mineral substances which form a small class by themselves—standing apart from all others by the possession of such exceptional characters that they have always attracted the attention of persons endowed with taste and refinement. These minerals, distinguished as *Precious Stones*, are nine in number, namely:—the

Diamond.	Chrysoberyl (True Cat's Eye).
Ruby.	Alexandrite.
Sapphire.	Opal.
Spinel.	Turquoise.
Emerald.	

The characters which have commended such stones in all ages, for purposes of personal ornament, are chiefly their brilliancy and colour, their durability and rarity. It is not sufficient, however, that a stone should possess only one of these characteristics. The mineralogist is familiar with many stones that are exquisite in colour, yet far too soft to be used for the practical purpose of decoration; on the other hand, there may be stones of exceeding hardness

and durability, yet destitute of any beauty of colour or lustre, and therefore unfitted for personal adornment. Colour alone is by no means a necessary property in a precious stone: the Diamond, for example, though presenting in some of its varieties every known tint, may be absolutely destitute of colour; nevertheless, it possesses the power of breaking up the rays of light which fall upon it, or pass into its substance, into rainbow-like tints of transcendent beauty. The Diamond, in fact, unites the properties of the most opposite elements—combining the purity of *water* with the flash of *fire*.

Precious Stones are frequently known also as *Gems*. It should be borne in mind, however, that this term is sometimes restricted by collectors of works of art to engraved stones—that is, to *camei* and *intagli*, especially those which have come down to us from classical antiquity or from mediæval times. It may, therefore, be convenient, in order to avoid confusion, to refer to the precious minerals themselves as *Gem-stones* rather than as Gems.

It is difficult to arrange the various Precious Stones in the order of their relative value, since the order is subject to occasional variation according to the caprice of fashion or the rarity of the stones. Nevertheless it is believed that the following scheme, in which all Precious and Semi-Precious Stones are grouped in five classes, fairly indicates the relative rank which they take at the present day.

I. The *Pearl* stands pre-eminent. It is true that this substance, being the product of a mollusc or shell-fish, is not strictly a mineral. It is, however, so intimately related in many ways with the family of true Precious Stones that it properly claims a place in any classification such as that under discussion. The Pearl has increased so greatly in value in recent times, that if one of a certain size

and weight was worth from £60 to £80 twenty years ago, the same Pearl is now worth from £500 to £600.

II. In the second class, and therefore at the head of the group of Precious Stones proper, stands beyond all doubt the *Burma Ruby*.

III. Then comes the *Diamond*. Many readers may be surprised to find the Diamond taking so subordinate a rank; but the time has gone by when this stone could claim a supreme position in the market. At the present day certain mines in South Africa produce Diamonds of pure water, rivalling the finest stones that were ever brought to light from the mines of India, Brazil, or elsewhere.

IV. In the fourth class comes first the *Emerald*, then the *Sapphire*, the *Oriental Cat's Eye*, the *Alexandrite*, and afterwards the *Precious Opal*.

V. In the fifth class may be placed under semi-precious stones the *Peridot*, the *Hyacinth* or *Jacinth*, the *Topaz*, the *Zircon*, and some 39 other varieties. Some of these are so beautiful that they deserve a more extended use in the arts of jewelry than they enjoy at present.

That branch of Mineralogy which deals with Precious Stones is known in Germany under the special name of *Edelsteinkunde*. But neither in this country nor in France does it possess any distinctive title. Perhaps it may be best designated in English as "The Science of Jewelry." So far from being a trivial or frivolous study, the Science of Gems and Jewelry implies a knowledge of all the properties and peculiarities of Precious Stones, such as their physical and chemical properties; the relation they bear to other minerals; their shape and structure; their defects and impurities. This science must, therefore include a competent knowledge of Crystallography, Physics, Chemistry and Geology. Such knowledge in its entirety

cannot be expected to be found outside the laboratory or the cabinet of the mineralogist. There are, however, several comparatively simple means of great value for the identification of Precious Stones, and as these admit of application without any profound knowledge of mineralogy they are given in an Appendix to the present work.

CHAPTER II.

WHERE PRECIOUS STONES ARE FOUND.

IT is a familiar fact that Organic Nature does not present an equal development of life in every part of the world. Each country—or at least each zone of climate—has its own fauna and flora—its peculiar assemblage of animals and plants. No one needs to be reminded that the animals and plants of the tropics are widely different from those of temperate zones, while these again differ from those of the Polar regions. But when we turn to the *Inorganic* world, we fail to detect any similar laws of distribution. Climate, so far as we know, is without sensible effect on the development of minerals and rocks. Many minerals are common to the hottest and the coldest parts of the world; yet they present no discernible difference whether brought from tropical or from Polar regions. It is true that occasionally there are slight local differences in crystallization, or in other physical characters, sufficient to enable an experienced mineralogist to say at once from what district a given mineral has been obtained. But these trivial differences are due rather to geological than to geographical conditions, and climatic influences have nothing whatever to do with the distribution of minerals.

Nor is this general rule in any way broken by those exceptional minerals which we distinguish as Precious Stones. It was a pardonable supposition of ancient

writers on gems that these beautiful productions of the mineral world should be mainly confined to tropical countries. What more natural than the conjecture that those favoured regions which gave birth to gaily-coloured birds and gorgeous butterflies and flowers of surpassing loveliness should also produce minerals of the rarest brilliancy and beauty! Yet such a supposition is purely fanciful.

Precious Stones, in truth, are not confined to definite geographical limits or to particular climates, but occur abundantly and in about equal perfection in all latitudes. Nor do the gem stones of one country necessarily differ from those of other parts of the world. The Diamonds of India, for example, are hardly, if at all, to be distinguished, when polished, from those found in the Ural mountains, or in Brazil, or at the Jagersfontein Mine in South Africa. The Emerald of New Granada, again, is much the same as that which is found in Queen Cleopatra's mines in Upper Egypt or at Katharineburg, in the Urals. The Beryl of Siberia has proved no unequal rival to that of Brazil, and the Amethysts of the Bavarian Palatinate equal those found in the most favoured spots of South America.

It is not, indeed, the geographical position which determines the difference between the relative values of the sites. Nevertheless it is an acknowledged fact that in India, Burma, Ceylon, Siam, Brazil, and in some of the Western States of America, a greater abundance of them has been discovered than elsewhere.

The Ancients were wont to ascribe the pre-eminence of certain regions in which Precious Stones are found to evaporation from the earth which would obviously be more intense in tropical countries. It was a supposition pardonably fanciful, that the sunburnt tropics were more

favourable to the blossoms of the inorganic world, than the dark skies of the north.

But although modern researches have shewn that Precious Stones are not limited to any defined geographical area, their distribution is yet in a measure circumscribed, inasmuch as they are not met with in all mountain ranges, nor in all geological formations. The most valuable are found in such ranges as are composed of rocks considered to be among the most ancient in the world—in rocks composed of granite, gneiss, porphyry, mica-schist, and crystalline limestone. Sometimes they occur imbedded in the mass of the rock; at other times, protruding, as it were, from the surface and jutting forth into free cavities. When they are thus found in the very rocks where they were originally formed they are said to be in their *primitive* bed.

Many however, are found far from their primal home, in a *derivative* or secondary deposit, in diluvial or alluvial soils, in the gravels or sands of river-beds. This last mode of occurrence is perhaps the most frequent for the finer Precious Stones. Far removed from their native home by the force of heavy rains and rushing torrents, they have been loosened and carried onwards, rounded by friction against the *débris* with which they have been accompanied in their course. It is a strange fact that those stones which have been washed in the currents or deposited in river-beds, are generally found to be the finest. Possibly this may be explained by a process of natural selection which has weeded out the faulty stones, and left only those that, by their superior hardness, could survive the rough usage to which they have been subjected. It is their hardness and density that have not only preserved them from destruction, but have enabled many to retain traces of their original

crystalline form. The Pearl, however, being composed only of carbonate of lime, when travelling with hard stones, would in time suffer complete destruction.

In Ceylon, India, Burma, Siam, Brazil, Australia, Siberia, South Africa, Borneo, and parts of the United States—from which countries the great majority of our Precious Stones are obtained—they commonly occur in these derivative beds; and it is interesting to notice how various kinds of Precious Stones are found in company in the same locality, forming as it were a noble society of Gems, rendered still more illustrious by their association with the noble metals—gold and platinum. It is noteworthy, however, that the majority of the South African Diamonds are unearthed from a rock which fills certain volcanic pipes and is considered by some mineralogists to represent the matrix in which the stones have been developed, though it must be confessed that much can be said against such a view.

The habitat, or native home of each Precious Stone, and the conditions under which it occurs, will be specially indicated in this work in the description of the individual gems.

CHAPTER III.

PRECIOUS STONES AND THEIR USES IN BYGONE TIMES.

HISTORY and tradition testify to the fact that Precious Stones were valued and preserved thousands of years ago. In India, where the most costly were chiefly found, this was especially the case. Other lands, it is true, possessed Precious Stones, and handed them down from generation to generation, but probably knew less of their true worth or nature. Their transparency and dazzling beauty, their hardness and crystalline forms, must naturally have always excited wonder, and induced men to treasure them as amulets, if not to use them as personal ornaments. We know that in the time of Solomon, the love of grace and luxury induced the rich to desire the possession of Precious Stones, and even to seek for them in foreign lands.

In Egypt, in ancient times, many stones were worked as scarabæan gems; and we know that among the Jews the robes of the High Priest were set with Precious Stones. It is often difficult, in reading an ancient author, to know precisely what stone he intends to indicate, and ordinary translations of technical words are by no means to be trusted. This remark applies, for example, to the names of the stones of the breast-plate of the Jewish High Priest, as rendered in our Authorized Version. The names which the Hebrews gave to these stones indicate that they derived their knowledge of them from the Egyptians, who in common with other ancient races, knew but little of what

we understand by Mineralogy. As regards India, Strabo and Pliny tell us that gold and Precious Stones were used for personal adornment, and that drinking cups were set with Emeralds, Beryls and Rubies.

From the East the Phœnicians, in their universal traffic, exported costly stones as well as ivory, with Tyrian purple and other stuffs, which were known as early as the Homeric period. The songs of Homer contain references to valuable bright stuffs and stones which served for ornaments, without mentioning their special names or qualities. For instance "The witch puts on her costly robe and brilliant earrings;" but their nature is not defined. Eurymachus gives to Penelope an exquisitely worked necklace of gold, ornamented with light amber, bright as the sun. Eurydamas also gives magnificent earrings, such as must have been worn by high-born ladies and princesses in Homeric times.

Besides the Precious Stones recorded in Genesis and Exodus, the precious Onyx and the Sapphire are mentioned by Job, with the Coral, Pearls, Rubies, and Topaz of Ethiopia; and the place in which some were found appears to have been known by the patriarch of Uz; "He putteth forth His hand upon the rock: He cutteth out rivers among the rocks, and His eye seeth every precious thing."

Six or seven hundred years before the Christian Era, the Greeks were acquainted with a multitude of Precious Stones, and the rulers in Greece and neighbouring lands wore ornamental and signet rings set with gems, such as Ruby and Sapphire. The famous ring of Polycrates (died B.C. 522) was doubtless as valuable to him for its costly stones and workmanship, as for any hidden virtue which it is said to have possessed.

In the beginning of the 5th century, B.C., we find

among the Greeks, a didactic History of Precious Stones; which indicates that their knowledge of them was not superficial.

Onomacritus, a Priest and founder of Hellenic mysteries, 500 years B.C., treated of Precious Stones and their mysterious power. Commencing with the bright transparent crystal, he says, "Whoso goes into the Temple with this in his hand may be quite sure of having his prayer granted; as the gods cannot withstand its power." Further, he states, that when this stone is laid upon dry wood, so that the sun's rays may shine upon it, there will soon be seen smoke, then fire, then a bright flame. This flame was known as *holy fire*, and it was believed that no sacrifice was so acceptable to the gods as when offered through its agency. In like manner Onomacritus sang the praises and supernatural power of the Agate, the Topaz, the spring-green Jasper, Amber, Chrysolite, Coral and Opal.

The superstitions attached to these and other stones were not confined to the Ancients. Even in this enlightened age, Eugénie, the late Empress of France, would not wear a precious Opal because it was said to bring ill luck to the wearer. Queen Victoria, on the contrary, having no such superstition presented each of her daughters, on her marriage, with a parure of Opals and Diamonds.

After the early Greek period the knowledge of Precious Stones advanced. Herodotus must have had accurate acquaintance with many of them. He mentions, besides the Emerald in Polycrates' ring, signet rings, such as that of Darius; and speaks of the so-called Emerald column in the Temple of Hercules at Tyre, which at night gave out a wonderful light. Plato mentions the Sard, Jasper, and Emerald. The Adamas, Amber, and Loadstone were not unknown to him; and he shows some

knowledge of the origin of both common and Precious Stones, and of their natural forms.

It is certain that Aristotle had knowledge of a still larger number of Precious Stones, and that he was acquainted with some of their special properties. His scholar, Theophrastus, has left us a small work on this subject. The little treatise of Theophrastus, Περὶ τῶν Λιθῶν, was written before the year 300 B.C., and notwithstanding its brevity, is of special interest as being the earliest Greek work devoted to Mineralogy which has come down to modern times. It is true there exists a curious Greek poem on Precious Stones, Λιθικα, by the pseudo-Orpheus, but this is of very little value from a scientific point of view, and its date is a matter on which the opinion of scholars is divided.

But though we have no other early Greek treatises on minerals, we find references to Precious Stones occasionally interspersed through the pages of other writers. Didorus mentions the Topaz found in the Serpent Island of the Arabian Sea, probably what we now call Chrysolite. Dionysius Periegetes refers to the clear and brilliant Diamond, the beautiful Asterios (a star-stone, either Sapphire or Ruby) that glitters like a star, the Lychnis with the colour of fire, the blue Beryl, the dull Jasper, the pure bluish and greenish Topaz, and the lovely Amethyst with its soft, purple sheen.

In the time of Alexander the Great, and still more so in the time of the luxurious Diadochi, there was a great increase in the use of Precious Stones as articles of luxury. They were used not only for signet rings, but also in ornamenting many articles of use and luxury, being set round the feet and other parts of the drinking vessels and candelabra of the period.

After the Romans became possessed of the treasures of Asia and Africa, they probably gained a much fuller knowledge of Precious Stones. The elder Pliny must have been better informed than his predecessors as to the places where gems were found. From him also we gain most of our knowledge of the views of the Ancients as to Precious Stones. During this period the luxury of Rome in respect to Precious Stones was enormous. The Emperors adorned their robes with jewels of immense value. Paulina, the wife of Caligula, covered her dress entirely with Emeralds and Pearls of untold wealth. Pliny says "we drink out of a mass of gems, and our drinking vessels are formed of Emeralds." A little later they began to mount their sacred pictures in frames set round with gems. Constantine entered Rome in a chariot of gold, adorned with Precious Stones, which are described as having sent forth brilliant rays of light. In his time the Royal Crown was first set about with similar gems, a custom which has been continued to the present day.

Passing on to the Christian Era we find among writers upon Precious Stones, that Isidorus, Bishop of Seville, in the year 630 A.D., takes a prominent place. He classified gems according to their colour. In the eleventh century Marbodus, Bishop of Rennes, wrote a *Lapidarium*, or Latin poem on stones, of which a Norman-French version is also known. A century later brought forth a really scientific treatise by Mohammed Ben Mansur—a work marked by great acumen, and evidently the result of an extensive acquaintance with the stones which he describes. Coming down to later times, attention may be specially directed to the treatise *De Gemmis et Lapidibus*, written in 1609 by a Dutch physician, Anselmus de Boot, whose name is better known in its Latinised form of Boethius.

Most of the old writers on Precious Stones occupied themselves to a large extent with the study of the occult virtues which they attributed to these substances.

The properties ascribed to Precious Stones in the time of Isidorus were extremely curious. They were said to have the power of conferring upon their happy possessors a host of blessings—health, beauty, riches, honour, good fortune, and influence. No wonder that men and women carried them about their person, prizing them as amulets.

Precious Stones were also supposed to have some connection with the planets and the seasons, and a special gem was worn for each *month*. The following is a list of appropriate Stones:

IN JANUARY ... THE ALEXANDRITE.
This gem holds its sway over the lives of those whose birthday falls in January and insures to them the undying devotion of the object of their choice.

" FEBRUARY ... THE AMETHYST.
To this stone's reputed power of preventing intoxication, it adds that of engendering a deep rooted love.

" MARCH ... THE SAPPHIRE.
The type of constancy, virtue and truth.

" APRIL ... ... THE DIAMOND.
Typifies purity and preserves peace.

" MAY ... ... THE EMERALD.
Possesses unconquerable power to combat sin and trial.

" JUNE ... ... THE CHRYSOPRASE.
Emblematic of eloquence and good luck.

IN JULY ... ... THE RUBY.
Type of Charity, Dignity and Divine Power.

„ AUGUST ... THE PERIDOT.
Emblematic of Modesty and Chastity.

„ SEPTEMBER .. THE CHRYSOLITE.
Confers the power of gladdening the heart.

„ OCTOBER ... THE OPAL.
Typifies Hope, Innocence and Purity.

„ NOVEMBER ... THE CHRYSOBERYL CAT'S EYE.
Warns the wearer of approaching danger.

„ DECEMBER ... THE TURQUOISE.
Emblem of prosperity, and the cheerer of the soul.

The Twelve Apostles, also, were represented in mediæval times by gems, called *Apostle-Stones*, viz. :—

1. *Jasper.*—This hard and solid stone representing the Church, was the emblem of *Peter.*
2. *Sapphire.*—The bright-blue Sapphire was emblematic of the heavenly faith of *Andrew.*
3. *Emerald.*—The Emerald, of the pure and gentle *John.*
4. *Chalcedony.*—The White Chalcedony, of *James.*
5. *Sardonyx.*—The friendly Sardonyx, of *Philip.*
6. *Carnelian.*—The red Carnelian, of martyr *Bartholomew.*
7. *Chrysolite.*—The Chrysolite, pure as sunlight, of *Matthias.*
8. *Beryl.*—The indefinite Beryl, of the doubting *Thomas.*
9. *Topaz.*—The Topaz, of the delicate *James the younger.*

10 *Chrysoprase.*—The Chrysoprase of the serene and trustful *Thaddeus.*

11. *Amethyst.*—The Amethyst, of *Matthew the Apostle.*

12. *Hyacinth.*—The pink Hyacinth of the sweet-tempered *Simeon* of Cana.

The *Alphabet* has been formed of the initials of Precious and Semi-Precious Stones and is still in use to some extent at the present day. The nature of this alphabet is exemplified by the following table:—

	Transparent.	*Opaque.*
A.	Amethyst,	Agate, or
	Alexandrite.	Avanturine.
	Almandine, or	
	Amber	
B.	Beryl.	Bloodstone.
C.	Chrysoberyl,	Cacholong,
	Carbuncle,	Carnelian,
	Cairngorm,	Chrysoprase, or
	Cinnamon Stone, or	Cat's Eye.
	Cymophane.	
D.	Diamond.	Diaspore.
E.	Emerald.	Egyptian Pebble.
F.	Felspar.	Firestone.
G.	Garnet.	Granite.
H.	Hyacinth, or	Heliotrope.
	Hiddenite.	
I.	Idocrase,	Jasper, or
	Iolite	Jet.
	Jargoon.	
K.	Kyanite.	Krokidolite.
L.	Lynx-sapphire.	Lapis-lazuli.
M.	Moonstone, or	Malachite, or
	Moroxite.	Marcasite

N.	Natrolite.	Nephrite
O	Opal.	Onyx.
P.	Pyrope, or Peridot	Porphyry, or Plasma.
Q.	Quartz.	Quartz-agate.
R.	Ruby.	Rose-quartz.
S.	Sapphire, Spinel, or Sphene.	Sard, or Sardonyx.
T.	Topaz, or Tourmaline.	Turquoise.
U.	Uranite.	Ultra-marine
V.	Vesuvianite.	Verd-antique.
W.	Water-sapphire.	Wood-opal.
X.	Xanthite.	Xylotile.
Z.	Zircon.	Zurlite.

If, for instance, it were required to represent the word *Alice* in a ring, the jeweller might choose Amethyst, Lynx-sapphire, Idocrase, Chrysoberyl and Emerald ; or any other group of stones whose initial letters spell the name.

CHAPTER IV.

THE WORKING OF PRECIOUS STONES.

ALTHOUGH Professor Ruskin, in an eloquent lecture delivered many years ago at the London Institution, advised the ladies to wear uncut Precious Stones, it may be safely said that the eccentric advice of the learned professor will never be followed, either by the public at large, or by those connoisseurs who appreciate the true beauty of a noble mineral. It is undeniable that the qualities for which Precious Stones are most prized,—their lustre, transparency, refraction, and dispersion of light,—may be to some extent visible even in their rough state; but in order to enhance these advantages, and to render them more attractive to lovers of beauty, the Diamond must be subjected to cleaving, bruting, cutting, and polishing, while coloured stones must in like manner be submitted to the art of the skilful lapidary, who brings out all the brilliancy and colour of the stone, while concealing its imperfections.

The cleaving, bruting, cutting, and polishing appertain to the art of the diamond-cutter, whose aim is so to manipulate the rough stone, as to produce with the least possible loss of weight, a regular, or symmetrical form, bounded by smooth, brilliant surfaces, called *facets*. The subsequent cutting of designs or mottoes in the polished stone belongs to the art of the stone-engraver.

It does not appear that the Ancients appreciated the art of the lapidary as highly as we do. They preferred

weight to brilliancy, and size to effectiveness. They would have been horrified to sacrifice eighty carats of a stone weighing 186 carats—as was done in the case of the Koh-i-nûr—merely to enhance its effectiveness as a gem. To-day, on the contrary, we should be satisfied with a stone of eighty-six carats, if by losing the 100 we could obtain nearly a perfect gem. Accordingly, we see that the ancient lapidaries were generally content to rub down the angles, polish the surfaces, and retain, to a great extent, the natural shape each stone possessed when discovered.

The clasp of the regal mantle of Charlemagne, in the French National Collection, is set with Diamonds which have the natural planes of the octahedron only partially polished. In the year 1290 there was formed in Paris, a guild of gem-polishers and cutters, and in 1373 the art of diamond polishing was practised in Nuremberg; the mode of procedure is, however, unknown to us. It was not till a subsequent date, that the famed "table-cutters" of Nuremberg formed themselves, in conjunction with the stone-engravers, into a regular guild. One of their rules was that apprentices to the lapidary's and engraver's art should be bound to serve for five or six years, under the pretext of the great difficulty and responsibility of their mystery, before they might venture to set up in business for themselves.

On Church ornaments of unascertained periods, but undoubtedly of great antiquity, Diamonds have been found having upper table-like surfaces with four polished borders, and the lower sides cut as four-sided prisms or pyramids.

In the inventory of the jewels of Louis, Duke of Anjou, exhibited in the years 1360—1368, the following cut Diamonds are mentioned:—(1) a Diamond of a shield shape, from a reliquary; (2) two small Diamonds, from

the same reliquary, with three flat-cut, four-cornered facets, on both sides; (3) a small Diamond in the form of a round mirror, set in a salt-cellar; (4) a thick Diamond, with four facets; (5) a Diamond, in the form of a lozenge; (6) an eight-sided, and (7) a six-sided plain Diamond.

In the beginning of the fifteenth century, there are found traces of the art of Diamond-polishing in Paris, and there still exists in that capital a cross-way called La Courarie, where the Diamond-workers resided more than two hundred and fifty years ago.

In 1407, Diamond-cutting made great strides under Hermann, an able artist. The Duke of Burgundy gave a magnificent dinner at the Louvre to the King of France and his Court, and the noble guests received eleven Diamonds set in gold. These gems were but imperfectly cut, yet with the intention and desire of heightening the play of light, and thus rendering the gift more gratifying to the guests they were intended to honor.

In 1434 Guttenberg learnt gem-cutting and polishing of Andreas Drytzehen of Strasbourg. It is known, too, that in the year 1590, a Frenchman, Claudius de la Croix, went to Nuremberg, and carried on the cutting of Rose Garnets.

It was in Bruges, in 1456, that Louis de Berquem who had lived long in Paris, made known his famous discovery of a mode of cutting the Diamond into regular facets. This increased the play of light considerably, and wrought so thorough a revolution in the jeweller's art, that his contemporaries regarded him as the father of Diamond-polishing and cutting. Just ten years afterwards, a guild of diamond-cutters and lapidaries was established in Bruges.

In 1475, Louis de Berquem made his first experiment

with the object of obtaining *the perfect cut*, on three rough Diamonds of extraordinary dimensions, sent to him by Charles the Bold, Duke of Burgundy.

No. 1., historically known as the "Beau Sancy," was a thick stone, cut all over with facets. The author has had this stone examined and many models of it taken, and his impression is that the stone commonly called the "Beau Sancy" is the work of an Indian lapidary.

No. 2 passed into the hands of Pope Sixtus IV.

No. 3, a badly proportioned stone, shaped as a triangle, was set in a ring, which, as a symbol of constancy, represented two hands clasped. Strange to say, it fell into the hands of that most faithless and inconstant of kings, Louis XI. It was presented to him by the Duke of Burgundy. Robert de Berquem relates that his grandfather, Louis, received from Charles the Bold 3000 ducats for his work.

Of Louis' pupils, many went to Antwerp, some to Amsterdam, and others to Paris. In the last named city the art of diamond-cutting did not flourish at once, owing possibly to want of encouragement and to lack of raw material. It made some progress, however, under the powerful influence of Cardinal Mazarin, who ordered twelve of the thickest Diamonds of the French crown to be re-cut, and thenceforward they received the name of "the twelve Mazarins." No one knows what ultimately became of these costly stones. In the inventory of the French Crown Jewels, in 1774, there is only one, with the number 349, to which the name "tenth Mazarin" is given. This was a four-cornered Brilliant, with somewhat obtuse angles, of pure water, weighing sixteen carats, and valued at £2000.

Owing to the patronage of the Cardinal, and the taste

for Diamonds which prevailed among the higher classes in France, the art prospered in the seventeenth century.

Towards the end of the same century, Vincenzio Bruzzi, of Venice, experimented on coloured Diamonds, with the view of extracting the colour and leaving the Diamond white. This art is practised to some extent even at the present day, but with little success, as the colour always returns after a greater or less interval. De Boot, who wrote in 1609, asserts that his patron, the Emperor Rudolph II., had obtained, by the distillation of antimony, a secret preparation with which he was enabled to remove not only the colour but the flaws of imperfect Diamonds.

About the close of the seventeenth century, Paris possessed seventy-five diamond cutters in full work, and amongst them not a few very clever masters. One Jarlet cut a Diamond for the Russian Crown, of 90 carats weight. The prospect which seemed now to promise great things for the diamond cutters at Paris was, however, but short-lived; it soon became overclouded, and before the end of the century, the trade was well-nigh extinct. In 1775 there were only seven masters left in that city, and these gained but a scanty and precarious living. The re-cutting of old Diamonds was a thing of the past, and there were over 3832 carats of rough stones waiting to be cut. In consequence of the political troubles and the social disorder which closed in blood at this memorable epoch, the Diamonds had to be sent from Paris to be cut in Antwerp.

London has always had lapidaries and diamond cutters of great ability, and the "Old English cutting" (so termed in the trade) is looked upon as the type of the best workmanship; yet, as the competition of skilled hands in Holland vastly exceeds that in England, the labour is less expensive for diamond-cutting, and the art is more

cultivated there than here. The English lapidaries are unrivalled in the cutting of coloured stones, but in the case of Diamonds, we must yield the palm to the Dutch. Of late years, however, the art of diamond-cutting has been revived here, and a stone can be cut in England to-day quite as well as in Holland.

When Portugal was at the height of her power, a very extensive trade in Precious Stones was carried on in that country by the Jews, and the lapidaries of Lisbon, who were also Jews, developed their art to a state of perfection never, perhaps, surpassed; many of the old Lisbon-cut gems exhibiting a beauty of workmanship that taxes all the skill of our first lapidaries to rival. But the lapidary and merchant, however wealthy, were powerless to hold their own against religious fanaticism and bigotry, and the expulsion of the Jews from Portugal in the latter part of the sixteenth century, drove the lapidary and his art from Lisbon.

The exiled gem-merchants and lapidaries found an asylum in Holland, carrying their trade with them, in the same manner as the Huguenots brought silk-weaving to England. Since that time Amsterdam has been the great centre of the Diamond cutting trade, and remains so to the present day. It is said that out of 35,000 Jewish inhabitants of Amsterdam, about one-third are in some way or other connected with this business.

In India the stones are very imperfectly cut by the natives, often being quite irregular, and cut on one side only. The size and weight of the stones are valued there rather than the artistic cut. In workman's language the stones cut in India are "lumpy," and it is easier to cut a Diamond from the rough than to re-cut one of these lumpy stones.

DIAMOND CUTTING.

The Diamond, the hardest of all known bodies, can only be manipulated by means of powdered Diamond. This powder is prepared generally from bort, or faulty Diamonds, and from the refuse in cleaving and cutting, which, being put into a mortar of hardened steel, is pounded until it is fine enough for use.

The industry of Diamond cutting has been more or less in the hands of the Jews for the past 200 years. This may be attributed to the scientific and elaborate system they established of naming every facet on the Diamond and training the workman to detect at once the exact grain of that particular facet. They divide the work into four branches, assigned to the cutter, polisher, setter and cleaver, and these all work into each other's hands.

As an example we will take the *cutter* first. All the rough stones pass through his hands. His first care is to examine every stone minutely for flaws and imperfections, enabling him, to decide in which way the Diamond will give the best attainable results. This done he takes a cutter box having two iron pegs for levers, and affixing two Diamonds on the ends of two boxwood sticks, made specially for this purpose, he proceeds to cut the Diamond on the old fashioned principle of "Diamond cut Diamond," technically known as "bruting." This is practically continued throughout the process, as there are no tools made of sufficient hardness to make any impression on the Diamond. Having decided which way to obtain the best result, the operator proceeds to cut the rough stone into a two-point, four-point, wass, drop briolette, rondelle, or table stone. We will now follow the first mentioned of these, the two-point, in its passage through the other branches of the trade and the system carried out to the finish.

The stone having been cut to the satisfaction of the master, is handed to the *setter* who selects a suitable sized brass cup, fills it with a mixture of lead and tin, and melts it over the gas flame. Having worked the solder to its proper shape, he places the Diamond in the centre, leaving only a very small part exposed. A mark is made on the solder before it becomes thoroughly set, and then the stone is passed on to the *polisher*. By the mark made on the solder the latter knows at once the precise run of the grain and the way in which it will polish to the best advantage on the mill. The first operation is making the "table" of the Diamond. This done it is handed back to the setter that he may take it out of the solder and reset it for the operation of making the first corner, called the flat corner. The solder is again marked to indicate to the polisher the run of the grain of this particular corner, and so the process is continued until the Diamond is polished throughout. Every facet has a name, and every name denotes the grain, and how to polish that particular facet. The polisher uses a mill or circular disc, composed of soft porous iron, so that as the Diamond is polished away in the form of dust it enters the pores of the iron, the result being that we have the Diamond cutting the Diamond. Without the assistance of the Diamond dust the iron would not make the slightest impression on the Diamond.

The next branch we have to deal with is the *cleaving*, an important part, but as only about 25 per cent. of the Diamonds found require cleaving the cleaver has not so much work to do as either the cutter or polisher. His work consists in taking a piece off a Diamond where it is too long, or making it into small stones where it is badly flawed, thus taking away all the impurities and defects, and leaving the sound parts to be cut and polished. To cleave a

Diamond he commences by fastening it to the end of a specially made stick with strong cement. A very sharp piece of Diamond, called a sharp, is similarly attached to another stick, and with it a V-shaped incision is made in the Diamond at the place where the part is to be removed. Placing a blunt knife in the incision and giving it a sharp tap with an iron cleaver's bar, the fragment immediately breaks off, if the incision is truly made and exactly on the grain. These fragments are cut and polished, and sold as Rose Diamonds. This is a distinct business from Diamond-cutting, but is carried out on exactly the same lines, the workmen requiring about the same length of time to learn either business, namely about six or seven years.

The great home for Diamond cutting is still Amsterdam, although, in order to diminish the price of cutting, Germany and Switzerland have also been tried—especially the latter, Switzerland being the great home for female labour; but the result has not been satisfactory, as will be seen by the following statement.

A parcel of rough stones coming from the Cape was divided into three equal portions of 100 carats each, and sent to each of the above-named countries. The cost of labour in Germany was only 1*s.* 6*d.* per carat below that of Amsterdam, yet the stones lost so much by the cutting that their value was less by 10*s.* per carat; and in like manner those of Switzerland, were 20*s.* per carat lower in value.

Only highly skilled and very honest artizans are entrusted with the cutting of large Diamonds. When the Diamond passes from the cutter's hands it is by no means perfect. The lustre and transparency for which it is so much valued are only fully developed in the hands of the polisher.

The polishing rocms of some of the great factories in Amsterdam, are well worthy of a visit.

The grinding and polishing of the Diamond are effected on flat wheels propelled by steam-power, which make about 2000 revolutions in a minute. Before these silently revolving discs you will see men so intent upon their work that they have eyes for nothing else; for, notwithstanding the perfection of the machinery, the skill of the workmen remains of primal importance. It is with their fingers and thumbs that they adjust the points, edges and facets of the Diamond with extreme accuracy, keeping them constantly moist with Diamond dust and olive oil. The thumbs of the workmen being used continually, and with much force, not unfrequently become enlarged.

The lapidary, who is occupied with the cutting and polishing of other precious stones than the Diamonds, or who is engaged simply upon Semi-Precious Stones, arranges his work much in the same manner as the Diamond-cutter, but he uses other means for the cutting and polishing, according to the nature of the stone to be worked. These special means will be noticed, where necessary, under the description of each particular stone.

THE FORMS OF PRECIOUS STONES.

The beauty of a cut or finished stone depends so much upon the form and position of its facets, that a moderately fine stone, well cut and polished, is of far greater value than a large one less artistically worked. It sometimes happens that the lapidary receives a stone of very unfortunate shape; his duty will, therefore, be to take all possible care to preserve its size; and, hiding its faults, give it such a

form as shall send it forth with the greatest weight consistent with beauty and brilliancy.

In selecting Precious Stones you must mentally ask yourself the following questions: Is their transparency conspicuous? Are they like dew-drops hanging from a damask rose leaf; are they of pure water, and do they possess the power of refraction in a high degree? Or, are they transparent and coloured; and, if the latter, have they a play of colour? Lastly, have they notable imperfections?

Transparent stones must not be too thick, for either they will refract light too strongly, or impede the light passing through, and thus rob the stone of its brilliancy and fire.

In colourless stones, the width and thickness which they must have are, as a rule, determinate; whilst in coloured ones they are regulated by the intensity and thoroughness of the colour.

The workman is compelled sometimes to give the stone a form other than that intended by nature, in consequence of flaws and clefts, and in order to remedy irregularities in the stone. This is most frequently the case in large stones.

Different forms of cutting receive different names, which are often extended to the finished stone itself. For instance, if you hear of a "Brilliant" or "Rose" you know at once that the first is a Diamond with a table and culet, whilst the second is only a low pyramidal stone, facetted over the top, but with the under surface quite flat.

1.—*THE BRILLIANT.*

This is the most favourable form for enhancing the play of colour, and is therefore most effective for all Precious

and most of the Semi-Precious Stones. It is said to be the crowning invention in the art of diamond-cutting. It was due originally to Vincenzio Peruzzi, of Venice; a city which was, in his time, the chief seat of the Diamond trade.

As a Brilliant, the Diamond has almost the form of two cones united by their bases; the upper one being so truncated as to give a large plane surface at the top, while the lower one is much less truncated, and in fact, terminates almost in a point. The stone being set with the broad plane uppermost, produces the effect of great depth of light, and its many facets increase what is termed its play of light; the density of the material naturally intensifying the refractive power, and thereby increasing its brilliancy. The plane surface at the top is called the *table*; the bottom plane is called the *culet* or *culette*; the junction of the upper truncated pyramid with the lower is the *girdle*; and the lower pointed portion the *pavilion*, Between the table and the girdle are generally thirty-two facets, and below the girdle twenty-four. These facets receive their names from their forms. *Star* facets are those whose edges abut on the table; the others are generally triangular. According to the number of facets, the Brilliant is said to be single, double, or Old English cut. The Brilliant depends greatly upon the facetting for its exceeding beauty.

The English make the girdle rather sharp; while the Dutch make it broader. The former method brings out the play of light better.

A form, called the "Star" was invented by M. Caire, to take advantage of the clear portions of rough Diamonds, which could not be otherwise used without great sacrifice of material. The Star-cut Diamond, as it is now worn, must be cut with extreme exactitude, avoiding the very slightest irregularity.

2.—*THE ROSE.*

This form, which has been in use since 1520, but is now quite out of fashion, is fancifully supposed to resemble an opening rose-bud. It is chosen when the loss to the stone would be great if the Brilliant cut were selected. The characteristic of the Rose is that it is flat below, and forms a hemisphere or low pyramid above, covered with small facets. The facets are in two rows: those in the upper row are called *star-facets*; those in the lower *diagonal facets.* In the centre there are generally six facets of triangular shape. A circular stone is best for the Rose the facets being more effectively brought out, and more easily polished than in a flat-shaped stone.

Although the Rose gives out a strong fire, and sends its rays as far as a Brilliant, yet, in the latter, the play of light is more remarkable, because the stone is deeper and the facets exactly correspond, thus making the prismatic colours more distinct. A Rose Diamond has very little value at the present day.

The number of facets, together with their position, decides the name of the Rose. A *Dutch Rose* is constituted of twenty-four facets; the *Rose Recoupée* of thirty-six; and the *Brabant Rose* of twelve or even fewer, only less raised than the Dutch.

3.—*INDIAN CUT.*

This has an upper part, lower part, and girdle. Its most frequent form is that of a single-cut Brilliant. In consequence of the small effect produced by this form it is generally re-cut to meet European requirements, but this operation is usually attended with a very great loss of weight to the stone; the natives always cutting the stone for weight and not for brilliancy.

4.—*POINT CUT.*

Stones may be pointed naturally or artificially. Some Precious Stones may either be cut as four-sided pyramids or are so formed by polishing the faces of the octahedron and making them exactly true and regular. This style of cutting is found in antique ornaments only, and was well-known to Kentmann in 1562.

5.—*BRIOLETTES.*

Briolettes are pear-shaped or oval stones, having neither table, culette, nor edge, but covered all round with triangular-shaped facets, and frequently pierced through at the top in order that they may be worn suspended.

6.—*PORTRAIT STONES.*

These consist of thin plates of Diamond, evenly polished on both sides, with little facets on the edges. They serve to cover portraits in Jewelry.

7.—*STEP-CUT OR GRADUATED FORM.*

When the facets gradually decrease as they approach the table and *culasse*, the gem is designated a "Step-cut." The style is effective, especially in coloured stones, the light being thereby better reflected, and the play of color intensified.

8.—*CONVEX STONES OR CABOCHON.*

When a stone receives one or two convex faces with

or without facets at the base, it is said to be *convex cut*, (*e.g* Almandine Garnet). But when its faces are simply polished, it is said to be cut *en cabochon*, as in the Opal and Cat's-eye. In ancient times the Sapphire was always so cut, and sometimes the Emerald and Ruby are now so treated, especially for the Russian and occasionally for the American market.

A stone cut with a flattish convex surface is said to be *tallow-topped*.

CHAPTER V.

THE ENGRAVING AND CARVING OF PRECIOUS STONES.

THE engraving of Precious and Semi-Precious Stones is an art of unknown antiquity. We know, however, that as early as the year 1490 B.C., the stones in the breast plate of the Jewish High-Priest were engraved with the names of the twelve tribes "like the engravings of a signet." (Exodus xxxix., 14). According to my reading the stones were as follow:

1st Row.	*2nd Row.*	*3rd Row.*
Diamond.	Opal.	Aquamarine, or Beryl.
Ruby.	Chrysolite, or Peridot.	Jacinth, or Hyacinth.
Sapphire.	Turquoise.	Zircon, or Jargoon.
Emerald.	Chrysoberyl.	Topaz, or Yellow Sapphire.

The design in an engraved stone is either sunk into the material below its surface, when the engraving is designated an *Intaglio*, or it is in relief, being raised above the ground or surface, a process to which the term *Cameo* is applied. Nearly all kinds of stones and gems have been treated by one or other of these methods, although for obvious reasons, brittle gems are not ordinarily selected as materials upon which the art of the engraver can be satisfactorily exercised. As a rule, the master-works in this department of art are on beautiful translucent stones. An

artist naturally does not care to expend his time and talent on a stone which will not display his work to the best advantage, and at its full worth.

For Cameos it is desirable to select large stones, remarkable for beauty of colour, with different layers or strata; although choice works of art have sometimes been elaborated on gems of only one colour.

The greater the number of layers that an Australian Opal or an Onyx or Sardonyx has, and the more beautiful and varied the colours which it presents, the more costly is the stone. The best stones for this particular work are those with a white layer on a dark ground. They are still better where there is a third layer above, such as white with a reddish or brownish tinge, which the artist can work into hair, wreaths, or dress. Entirely transparent Stones are very rarely used for Cameos.

Stone engraving is said to have been introduced into the West by Jews from Alexandria. In the Middle Ages and even in later times, when there was no great master in the Art of Engraving, the cut stones of the ancient Greeks and Romans were used as signet rings. King Pepin sealed with the Indian Bacchus, and Charlemagne with a stone representing Jupiter Serapis.

Later on, signet rings were engraved with the king's signature; and lovers were wont to exchange at their betrothal, rings cut to represent wishes or allegories.

In the fifteenth century, when Constantinople fell under the dominion of the Turk, the Greek artists left their fatherland, carrying with them into Italy their secret knowledge of stone engraving. The first fruits of this immigration were seen during the Pontificates of Martin V. and Paul II. Lorenzo de' Medici assisted the development of the art by affording to Giovanni Bernardi the means of

acquiring it both by instruction and by practice, so that he eventually received the cognomen of Giovanni delle Cornioli, in recognition of the perfection he had acquired in engraving Carnelians. His work was so exquisite that it bore favorable comparison with the masterpieces of old classic times, and he has been regarded as the restorer of the art of Stone Engraving in Italy. A contemporary of his, named Dominico de' Camei, employed himself in cutting beautiful Intaglios as well as Cameos. He sculptured on a pale red Ruby the likeness of Ludovico, the Moor, Duke of Milan.

The earliest trace of Stone Engraving in Germany is found in Nuremberg and Strasbourg, in the 15th and 16th centuries. France, England, and, in modern times, Rome have produced most excellent artists in Stone Engraving.

Modern artists have so well imitated the works of the Ancients that it is difficult even for a practised eye to distinguish the old gems from the new, when they are copied from the originals. The Egyptians and some other ancient peoples possessed very able workers in Stone Engraving; but it would be unjust to modern artists to declare that all excellence in this department belongs to the antique, as the originals have not only been equalled but even surpassed.

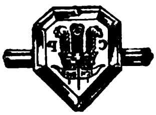
Francis I., of France, made the first collection of engraved stones; and the Duke of Orleans' collection in Paris was of world-wide celebrity. Many of the most beautiful of ancient gems are carefully preserved in Berlin, and in Vienna, Naples, Florence, in the Barberini Palace, in the Museum of Duke Odescalchi in Rome, and in St. Petersburg and Copenhagen. The Blacas collection, in the British Museum, is reported to contain some of the most valuable Intaglios in the world.

EXAMPLES OF ENGRAVED DIAMONDS.

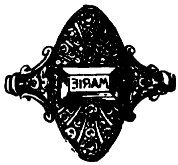

1


2


3


4

5


6


7

8


9

No. 1. Portrait of a Philosopher.
2. Head of Emperor Leopold II.
3. Engraved Cross.
4. Signet Ring used by Charles I. when Prince of Wales.
5. Signet Ring used by Henrietta Maria, Queen of Charles I.
6. A Ring, formerly the property of Marie Antoinette.
7. Signet Ring used by Mary of Modena, Queen of James II.
8. Impression from the Diamond Signet of Charles I.
9. Head of Emperor Napoleon I.

ENGRAVED DIAMONDS.

The Diamond, owing to its extreme hardness and consequent difficulty of working, has seldom been made the medium for this branch of the lapidary's art, and, in fact, so few notable examples of engraved Diamonds are in existence that it has been considered of sufficient importance and interest to devote a separate chapter to this subject, and to give a few illustrations of the more remarkable specimens of which we have authentic record.

It has been said that Clement Birago, of Milan, or his master Jacopo da Trezzo, discovered in 1556 the art of engraving the Diamond. According to Blum, Ambrosius Caradossa was the first to sculpture Diamonds, but as I have shewn above the art was known at the period of the exodus of the children of Israel, and probably very much earlier. The arms of Charles V. were engraved upon a Diamond by Jacopo da Trezzo; and his pupil Clement Birago engraved on another Diamond a portrait of the Spanish Prince Don Carlos. The arms of Queen Mary I. of England were executed on a Diamond by Jacobus Thronus.

It is stated that there are in a collection at Florence five fine examples of engraved Diamonds, four of which are signets; one engraved with the crowned arms of Portugal, one which belonged to Catherine de' Medici, engraved with a monogram of M.C. and coronet, another with the Medici shield crowned, and a small one with shield of arms and coronet.

The Duke of Bedford possesses a Diamond with the head of the philosopher Posidonius engraved on it: Kluge believed it to be an isolated example. In the late Hope collection there were three specimens, of which figures 1, 2, 3, in the plate of engraved Diamonds, placed opposite, are illustrations.

Mary of Modena, Queen of James II., possessed a Diamond signet with her cypher M.R. interlaced and surmounted by a crown (fig. 7).

That the engraving on Diamonds was not confined to foreigners is shewn by an interesting extract from the Privy Seal books of the office of the Clerk of the Pells, now in the Public Record Office (No. 11, p. 142), which is cited by Mr. C. Drury Fortnum in describing the Diamond signet of Queen Henrietta Maria. This entry states that on Jan. 16th, 1628—9, the sum of £267 (which would be equivalent to nearly £1,100 of present value) was paid to one Francis Walwyn, an English gem engraver, for cutting finishing, and polishing a Diamond and engraving upon it the arms of Charles I. with the initial letters of the name of his Queen on each side (fig. 5).

Other examples of Walwyn's handiwork are in existence, one being in the private collection of Gems and Jewels at Windsor Castle; namely, the Diamond signet ring used by Charles I. when Prince of Wales and engraved with the Prince of Wales's plume of feathers (fig. 4). Another is the impression of a seal affixed to some of the letters of King Charles I. (fig. 8). The cutting is very similar in character to that on his Queen's Diamond.

In 1877 an engraved Diamond was offered for sale; it was a thin stone, engraved with the head of the Emperor Napoleon I. The price was £1,000; but at such a sum it did not find a purchaser. This stone (represented in fig. 9) was exhibited in the Paris Exhibition of 1867.

A curious old Marquise ring which formerly belonged to Marie Antoinette, has in the centre an oblong Diamond engraved with her name, Marie: this is now in the collection of Streeter & Co, Ltd., and is represented by fig. 6, on p. 36.

At the present day, the art of gem engraving has arrived at such perfection that Diamonds are engraved like any other gem-stones. No difficulty is made, if taken to the proper artist. Any design, pattern, or arms may now be engraved on Diamonds, as on Rubies, Sapphires, or softer stones.

CHAPTER VI.

PRECIOUS STONES AS OBJECTS OF COMMERCE.

THE trade in Precious Stones has considerably increased since the year 1860. Discoveries have been made in many parts of the world, and S. Africa, India, Siam, Ceylon and Australia, now form the great emporiums.

Formerly Pegu, said to be famous for its market of beautiful gems of all kinds, received yearly a very large sum for its exports; so also did Ceylon, from which island we even now obtain some few of our coloured Stones, especially Cats' Eyes, Sapphires and Rubies generally of an inferior colour and quality. During the dynasty of the Kandy Rulers, the right of digging for Precious Stones was most jealously guarded as a royal prerogative, and the inhabitants of particular villages, under the supervision of hereditary overseers, were occupied in the search for gems.

A number of men are constantly occupied in this exciting and precarious business; and the idle and disorderly adventurers who visit the villages are the cause of great immorality among the inhabitants. The results of their labors they used to sell to the Malays who came to Saffragam with cloth and salt, which they exchanged for Precious Stones. At the yearly Bhudda Festival in August there is a jewel market held in Ratnapura, whither those interested in jewels flock from all parts of Ceylon.

The position of the people of Saffragam is so much improved of late years that they are able to retain for themselves any stones they find of great worth. Now and then they are induced to exchange them for Diamonds or gold, which they can equally well conceal. The artificers who cut and polish the stones on the spot are generally Malays. Their work was formerly very imperfect, and their knowledge of the art faulty, but of late years they have much improved in the art of cutting gems. Stones of inferior value, such as Cinnamon-stone and Tourmaline, are cut and polished by ordinary workmen in Kandy, Matura and Galle, while artistic and experienced workmen, who cut Sapphires, Cats' Eyes and Rubies, live chiefly in Kalutara, and Colombo.

The rare gems are cheaper in London than in Colombo. Precious Stones are brought from all parts of the world, both in the rough and native-cut to be re-cut by London lapidaries. In Ceylon the stock is so uncertain, that the price is largely determined at the moment by the rank and wealth of the buyers. The small Malay dealers do not purchase rare and fine jewels, knowing quite well that the best and finest specimens are carefully held back by the rich traders, or travellers, who consign them to England, or obtain from the native princes of India, who have an ardent passion for gems, such remuneration as keeps up the prices of high-class jewels.

It is quite impossible to judge accurately by the Customs' Register in Ceylon of the worth of the Precious Stones which are sent out of the island. Only a small part is directly consigned to England; the remainder is bought up by private hands, but, for the most part

ultimately finds its way to the English market. It is calculated roughly, that the value of Precious Stones found in the island amounts to over £20,000 yearly.

More than a hundred and fifty years ago Brazil became a powerful rival of India for Diamonds. The most beautiful stones were found in the nearly inaccessible wilds of Minas Geräes, by poor mulattoes and negroes, and sold to the merchants. While Brazil belonged to the Portuguese Crown, Lisbon enjoyed the largest share of the trade in Precious Stones. The trade was a prerogative of the Crown.

At the present day the remarkable development of Diamond-mining in South Africa has caused both the Indian and the Brazilian Diamond-mines to almost cease working.

In the trade of Precious Stones, the coloured stones stand far behind the Diamond; insomuch, that this stone alone represents about 90 per cent., and the others altogether only 10 per cent. of the quantity on sale.

Apart from the class to which the Precious Stone belongs, the price is determined by the beauty, the quality and play of colour, brilliancy, purity, rarity, the perfection of the cutting, and above all, the weight of the stone. This last quality greatly increases the price; for as the most beautiful stones are generally found in only small crystals, the value rises with the size of the gem.

In the case of Semi-Precious Stones, the size and colour also are much considered in determining the price, but these advantages are not so important as the artistic working of the stones. Stones depend mainly upon this adventitious circumstance for their actual worth. As a general maxim gems are valuable for their rarity, freedom from flaws and quality; fashion occasionally exercising influence in a greater or less degree upon their market

value. Thus the Emerald has recently increased in value tenfold.

At the Leipzig Easter Market, many years ago, Diamonds fell suddenly 50 per cent., owing to Dom Pedro having paid the interest of the Brazilian State-Debt to England in Diamonds instead of money, and thereby causing a glut in the market. In 1838 the price of Diamonds again rose, but in 1848, in consequence of the Revolution in France, it fell greatly. From that year until 1865 the value of Diamonds seems to have increased at about the rate of 5 per cent. per annum. Then, at the end of the Civil War in America it sprang up suddenly 25 per cent. At the end of the Franco-German war of 1871 it rose another 10 per cent. and during the next two years there was a gradual rise amounting to 20 per cent. Afterwards, owing to the panic in America, and the effect of the discoveries at the Cape, the market price steadily fell; but, with the revival of trade, fine Diamonds again reached a very high value, and specimen Diamonds now realise a larger price than ever.

In buying Precious Stones much precaution is required. Few wares are liable to more faults and imitations than these, and the faults alone are sufficient materially to lessen their value. In the rough stones they are not easily observed; and in manipulated gems they may be hidden to a large extent by clever workmanship.

Among the most frequent defects are: (1) *Feathers*: little rents or fissures in the inside of the stone; found in all kinds of Precious Stones. (2) *Clouds*: grey, brown and white spots, very like clouds, which much increase the labour of preparing the gem for sale; this fault is mostly found in Diamonds and pale Rubies. (3) *Sand*: or little seed-like bodies within the stone, of white, brown

or red colour: these are called *dust* when very fine and in large numbers in one stone. Absolute perfection is no more to be found in Diamonds and Precious Stones, than in any other created things; for, however perfect they may appear at first sight, there is, as a rule, some trifling defect discoverable on minute inspection. 25 per cent. of the Diamonds found have to be cleaved, whereby the Diamond-cutter is enabled to remove black spots or air-bubbles, or any other flaws in the stone.

THE FIRST KNOWN APPLICATION OF DIAMONDS FOR ORNAMENT.

The adaptability of the Diamond for personal ornament is grounded mainly on its conspicuous lustre and beautiful play of light, properties which are rendered prominent by cutting the stone, so as to give it the greatest number of surfaces consistent with its size. By this manipulation the rough stone loses an amount of material tending in some cases to more than one-half, and sometimes as much as two-thirds of its original weight.

The Tyrians are said to have been the first to apply the Diamond to personal ornament, but the author thinks this very doubtful, and believes that it was an article of commerce much earlier among the peoples of the East. They valued it highly, carried it as an amulet, and attributed to it many medical virtues. It was regarded also as a safeguard against madness.

The breastplate of Aaron previously referred to is mentioned in Exodus xxxix, 10 to 14. Jeremiah (xvii. 1) speaks of the sin of Judah being written with "the point of a Diamond,"—*puncto adamantis* of the Vulgate—though it is probable that this *adamas* was the corundum, and not

the true Diamond. Ezekiel says of the Tyrians:—"Thou hast been in Eden, the Garden of God; every precious stone was thy covering, the Sardius, Topaz and the Diamond, the Beryl, the Onyx, and the Jasper, the Sapphire, the Emerald, and the Carbuncle. . . . Thou hast walked up and down in the midst of the stones of fire." (Ez. xxviii. 13, 14).

The Chaldeans—who were the most superstitious people, and seem to have initiated the Jews into their mysteries, and their charms against evil and mischance—perverted the precious stones from their purpose of ornament and even of usefulness into idolatrous amulets, and fixed on them superstitious attributes, from which it has been found impossible to dissociate them, even at the present day.

In early times the Diamond was worn *rough*, or polished only on its upper surface. It was in this form that it was used to ornament temples, stage goblets, reliquaries, and crowns. In India the native uncut stones are still prized under the name of *Naifes.*

It was not until the time of Charles VII. that the French ladies began to adorn themselves with Diamonds. The well-known Agnes Sorrel was probably a leader of this fashion. Under Francis I. the ladies indulged to such an extent in Diamond ornaments that it gave rise to the saying, that "the ladies of France carried mills, forests, and lands, on their shoulders." The Luxus or Sumptuary Laws, in the reign of Charles IX. and Henry IV., were aimed at this extravagance.

After the introduction of the art of Diamond-cutting by Louis de Berquem, Diamonds were largely used for ornament; and at the present day a lady's dress is not considered complete without them.

The original cut of the Diamond was that of the table-form, with a row of facets above. It was not until the year 1520 that the Rose-cut was introduced, while the form of the Brilliant was not known until the reign of Louis XIII. of France. It was Cardinal Mazarin who first had the Diamond cut as a Brilliant.

CHAPTER VII.

THE BURNING AND COLOURING OF PRECIOUS STONES.

THE BURNING OF PRECIOUS STONES.

CERTAIN kinds of Precious Stones are often burnt or subjected to a high temperature, the heat exercising a very peculiar influence upon many stones, and in some cases modifying or utterly changing their colour.

Thus, the Oriental Carnelian owes its beautiful tint to artificial exposure to heat. The Pink Brazilian Topaz, too, derives its remarkable colour from burning.

One way of burning Precious Stones is to roll them up in a piece of sponge or tinder, and set fire to the enveloping material. Another method is to place them in a crucible, with either unslaked lime or iron-filings, and heat them until they are quite clear. Occasionally where a faulty stone with dark spots is burnt with sand and iron-filings, the spots are removed and the colour equalized; but the process requires great care.

Rubies are occasionally infected with white spots which can be removed by burning. Many coloured Jargoons have their tints more or less completely discharged on exposure to a high temperature. Smoky Rock-Crystal also, carefully heated in a crucible with lime, sand, or charcoal, will usually come out perfectly clear. The discharge of colour is evidently due to the decomposition of the organic matter, with which the stone was tinted.

THE DYEING OF PRECIOUS STONES.

The possibility of giving artificial colours to Precious Stones was not unknown to the Romans. Pliny relates that recipes were offered for sale which professed to turn Rock-Crystals into Emeralds and other transparent gems; that in India many Precious Stones were produced by dyeing Rock-Crystal, and that the Ethiopians deposited the pale Carbuncle in vinegar for fourteen days, when it was alleged that it would shine brilliantly for a similar number of months.

Respecting the artificial colouring of certain Agates, Pliny says that in his day more of these stones were probably coloured artificially than naturally: and that in Arabia the Agate-nodules, if cooked seven days and seven nights in honey, will, when prepared by the artist, present veins, stripes and spots, which increase their effectiveness as ornaments

This notion of honey purifying the Agate seems to be the foundation of the following beautiful idea: "All kinds of Precious Stones, cast into honey, become more brilliant thereby, each one according to its colour, and all persons become more acceptable in their vocation, when they join devotion with it: household cares are thereby rendered tranquil, the love of husband and wife more sincere, the service of the prince more faithful, and all kinds of business more easy and pleasant."—*Extract from the Introduction to "The Devout Life," by S. Francis de Sales. Chap. III., par.* 13. 1708.

In Oberstein and Idar—two neighbouring localities near Kreuznach, on the river Nahe, famous for many centuries for the industry of working in Agate—the artists have been eminently successful in colouring not only the surface but the inner depths of a great variety of siliceous

stones. The use of honey in the dyeing of stones was in early times the secret of a few Agate merchants at Idar, who obtained it from some Romans who periodically came to procure various kinds of Onyx from the stone-polishers at that place and at Oberstein. It is impossible to say whether these Romans acquired the knowledge by reading Pliny, or received it as a tradition in Italy.

The Art is based on the fact that the alternate layers of the Chalcedony, in the agate nodule are not equally porous, some strata readily absorbing a colouring liquid, while others imbibe little or none of it. The porosity of certain layers led the stone-polishers to conclude that they might so colour these as to render mean and insignificant-looking stones suitable for Cameos and cognate purposes, and thereby materially increase their value.

The Agate merchants before purchasing a stone, test the worth of the raw stone for dyeing by striking a thin piece off it, damping it with the tongue, and observing whether the drying of the stripes takes place quickly or slowly. If the stripes absorb the moisture readily, the stone is good for dyeing, and especially for Onyx-dyeing. This test, however, cannot always be relied on, and the manipulators are sometimes obliged to colour a small piece experimentally before buying the stones.

At Oberstein and Idar the Onyx is dyed in the following manner. The stone is twice washed, and then dried. It is next laid in honey and water (half-a-pound of honey to about sixteen or twenty ounces of water) or in sugar and water, or in oil. The dish in which it is laid must be clean. This is placed in a warm oven or on a stove, and care must be taken that the stone is always covered with the liquid, and that the liquid does not boil. This treatment is continued for a period of

from fourteen to twenty-one days. The stone is then taken out of the honey, or other medium, washed and placed in another dish with sulphuric acid. This dish is then covered, and placed in hot ashes with burning charcoal over the cover. During this process the acid is absorbed by the porous layers, and carbonizes the saccharine or oleaginous matter previously imbibed by the stone. In a very short time the stone will generally be dyed by means of the carbon deposited in its pores, which imparts to it a black or rich dark brown colour. Some stones require a longer time; and some will, despite all care, take no colour. The last step is to remove the stone from the sulphuric acid, wash it, dry it in the oven, and lay it in oil for a day: this imparts to it an increased clearness and brilliancy.

The stone known as "Brazilian Carnelian" is worked in great quantities in Oberstein and Idar: the red colour is produced usually by steeping the stone in a solution of green copperas, or ferrous sulphate, and then exposing it to heat.

The method of imparting a blue colour to Agate was introduced at Oberstein in 1845. By steeping the stone first in a solution of yellow prussiate of Potash and then in one of a ferric salt, a precipitate of Prussian blue is formed within the pores of the Agate. In other processes a solution of blue vitriol and ammonia is employed, so that an ammoniacal sulphate of copper, of magnificent colour, thus becomes the tinctorial agent.

Of late, exquisite blue dyes have been found for the Chalcedony, by which the varied shades of the more valuable Turquoise and *Lapis-Lazuli* are produced. Both the English and French markets have plentiful supplies of these artificially-tinted stones, but the precise mode of operating in order to produce the finest tints is known but to a few.

A green colour, resembling that of Chrysoprase, may be obtained by impregnating the Agate with certain salts of nickel or of chromium; while a yellow tint is obtained by digestion in warm muriatic acid, the iron in the stone being thus converted into a chloride. In fact, the chemical resources of the German Chemist now enable the worker to colour porous stones to any desired tint.

SECTION II.

CHAPTER I.

THE DIAMOND.

DIAMONDS, as they occur in Nature, usually but not invariably present the form of crystals, more or less regular and perfect in their development. These forms belong to the group of geometrical solids known to crystallographers as the *Cubic* or *Tesseral* or *Isometric* system. The most common forms are the regular ootahedron and the rhombic dodecahedron; the former bounded by eight equilateral triangles, and the latter by twelve rhombs, or lozenge-shaped surfaces. It is notable that the faces of the crystals are often more or less curved, or convex, whilst those of other crystalline bodies, with few exceptions, are flat. Not unfrequently the Diamond takes the form of a six-faced octahedron, which, by the rounding of its eight-and-forty faces becomes almost spherical or approaches a small ball in shape. In some cases the crystals are curiously "twinned" or "macled."

Groups of crystals, dodecahedra as well as octahedra, are not rare; there is for instance, a very fine specimen of such a mass of coalesced octahedra in the Royal Mineral Museum at Dresden. In the Vienna Collection there is a Diamond which has, enclosed within itself, another similarly-crystallised Diamond of a yellow-colour; and

the author observed a case in which on cleaving one from South Africa, a small Diamond of almost black colour fell out from its enclosure. Various included bodies, mostly microscopic, have been recorded by Brewster, Chatrian, and other observers.

The surface of a crystal of Diamond is generally smooth; but it is sometimes indented with triangular impressions, and in certain cases is striated with lines parallel to the edges of the octahedral faces. Some Diamonds present a rough surface, resembling poorly polished glass, and are not unfrequently dull, as though covered with a thin coating of gum. These generally cut into very fine white stones.

The Diamond is occasionally found in concretionary crystalline forms, which pass under the name of *Bort;* while another variety termed *Carbonado*, of brownish-black colour, is so indistinctly crystalline as to be often regarded as compact. These varieties will form the subject of a separate chapter.

The Diamond presents a perfect cleavage, parallel to the faces of the octahedron, which is its primary form. The Diamond cutter avails himself of his knowledge of this natural structure, and is thereby enabled in many cases to remove spots from a stone by cleaving, without resorting to the weary work of grinding. The famous Dr. Wollaston, in the early part of this century, was one of the first to call attention to the advantages offered by the ready cleavage of the Diamond. He purchased one from the firm of Messrs. Rundle & Bridge, which they considered too much flawed to be worth their while to cut, but the learned doctor minutely studied the structure of the stone, and having removed the defective part by cleavage had the perfect portion cut, when he re-sold it to Messrs.

Rundle & Bridge, for a sum which gave him a large profit. Long before Wollaston's time, however, there must have been many students of Precious Stones who were familiar with the cleavage of the Diamond. Thus De Boot, writing in 1609, tells us that he knew a physician who boasted that he could "divide a Diamond into small scales like a piece of talc." The fracture of the Diamond, apart from its cleavage, is conchoidal, and here and there the stone is liable to split off in fragments.

Among the physical properties of the Diamond that of hardness is pre-eminent; a quality in which it so exceeds all other bodies that it can penetrate them without being itself even scratched. In consequence of its excessive hardness it was formerly only possible to polish it partially, by rubbing it against another rough Diamond—a process which is known as "bruting." In early times there existed so exaggerated an idea of its extraordinary hardness that it was said a Diamond could not be broken by a hammer on an anvil, and that it was far easier to strike the anvil into the earth than to break the Diamond. This will account for the loss of many Diamonds in antiquity, as it was the absurd practice to place them upon the anvil to test their genuineness. Through this ignorance many a regal gem has been shattered and so lost to the world. It was, of course, only the *brittleness* of the stone which was really tested by the hammer, and not its hardness, which is a very different quality.

Pliny gives a detailed account of the Diamond in his "Natural History," xxxvii., 15. As translated by old Dr. Holland, he says: "The most valuable thing on earth is the Diamond, known only to kings, and to them imperfectly. . . . It is only engendered in the finest gold. . . . . Six different kinds are known. Among

these the Indian and Arabian, of such indomitable, unspeakable hardness, that when laid on the anvil it gives the blow back in such force as to shiver the hammer and anvil to pieces. It can also resist fire, for it is incapable of being burnt. . . . . This superiority over steel and fire is subdued by goat's blood, in which it must be soaked when the blood is fresh and warm; then only when the hammer is wielded with such force as break both it and the anvil, will it yield. . . . . Only a god could have communicated such a valuable secret to mankind. When at last it yields by means of the blood, it falls into such small pieces that they can scarcely be seen."

The curious opinions of the Ancients as to the infrangibility of the Diamond are discussed by Sir Thomas Browne, in his famous work on "Vulgar Errors," written in 1646. The doctor is naturally led to discard the old views, notwithstanding the support which they had received from the early Christian writers, and to conclude, on the evidence of practical diamond-cutters, that Diamonds "are so far from breaking hammers, that they submit unto pistillation, and resist not an ordinary pestle." As a matter of fact the Diamond is so brittle that it is readily reduced to grains, or powder, by pounding in a steel mortar.

Hardness is the best test of the genuineness of a Diamond. If a mineral cannot be scratched or cut by Ruby or Sapphire, it must be a Diamond. It is true that certain bodies, like Carborundum, recently formed in the electric furnace, are harder than Ruby or Sapphire; but these are not minerals.

It is notable that the hardness of the Diamond varies in different crystals, and even in different parts of the same crystal. The experience of diamond-cutters leads

to the conclusion that the Australian Diamonds are harder and tougher than the stones from India, Borneo and Brazil, while these again have a hardness superior to that of most of the stones from South Africa.

Optical Properties.—Refraction.

The conditions which the Diamond presents in relation to light are very remarkable. It is one of those bodies which refract light most strongly—that is to say, when a ray of light enters a Diamond, it is turned from its original path to a much greater extent than if it had entered a Topaz, or a Rock-Crystal, or a piece of glass, or, in fact, any other transparent medium. Hence the magnifying power of a Diamond is much greater than that of glass. It is said that if a Diamond and a piece of plate-glass be ground into lenses of similar form, the magnifying power of the Diamond will exceed that of glass in the ratio of 8 to 3. It was this that induced Mr. A. Pritchard, many years ago, to apply the Diamond as a microscopic lens; but owing to the great difficulty of manipulating it, so as to adapt it to the purpose, as well as its intrinsic value, its use was extremely restricted.

As the Diamond is found in nature as a crystalline solid substance, of distinct form, it has naturally been generally assumed to be a mineral production. Probably the first philosopher to throw doubt on this conclusion was Sir Isaac Newton. In his remarkable optical researches he had established a definite relation between the refractive power of a body and its density. The power of refraction in each body is expressed scientifically by a certain number, or numerical ratio, called the *index of refraction.*

Now, Newton found that the index of refraction of Diamond was much higher than he should have anticipated from the specific gravity of the stone. But he had observed that fatty and resinous bodies—such as oils, turpentine, and amber—possessed in like manner a higher refractive index than their density would suggest. Hence he was led to throw out the bold conjecture that the Diamond might be "an unctuous body coagulated!"

Reflection and Dispersion.

In addition to its property of strong refraction, the Diamond possesses the power, in an extraordinary degree, of reflecting and dispersing the rays of light, thus causing what is technically termed the "play of colors," observable on a well-cut Diamond. The optical term "dispersion" is applied to the power which a transparent substance possesses of breaking up the incident white light into prismatic tints, like those of the rainbow—a power which is enjoyed to an unusual extent by the Diamond, and gives rise to the splendid flashes of fire emitted by a stone which has been skilfully cut.

As the value of a Diamond depends very materially upon this play of colors, many methods have been essayed from time to time for testing it. Babinet recommended the following plan, which he himself was in the habit of employing, In a sheet of white paper he pierced a hole somewhat larger than the Diamond to be tested; he then let a ray of sun-light pass through the hole, and holding the Diamond a little distance from it, yet at such an angle as to allow the ray to alight on a point of a flat facet, he found this facet to be forthwith represented on the paper as a white figure, whilst all around little rainbow circles were delineated. If the observer found the primary colors,

i.e., red, yellow, and blue, definitely separated one from the other in these little circles, and if their number were considerable, and they stood at equal distances from each other, then he pronounced the Brilliant to be well cut.

The effulgency of a good Brilliant largely depends on the fact that by the small "critical angle" of a Diamond (24° 13′) much of the light which enters the stone, instead of passing through it, is "totally reflected" from some of the facets, and thus returns to the eye of the observer. In the Rose Diamond the light is reflected from the under-plane.

As the Diamond is a mineral which crystallizes in the cubic system, it does not, in its normal condition, possess the power of double refraction, neither does it polarize light; but Sir David Brewster long ago shewed that there are in many stones certain optical irregularities due to internal air-bubbles, cavities, or other flaws. The vapour or gas in these minute cavities is pent up under intense pressure, and the Diamond is thus thrown locally into a state of tension, which gives rise to double refraction. So great is the internal strain in some Diamonds, that they explode when unearthed from their matrix and brought up from the mine, especially when held in a warm hand, which naturally tends to expand the included gas.

Lustre and Colour.

The lustre of the Diamond is of that peculiar, indescribable, but well-known character termed *adamantine*. The surface of the native crystal is often rough, and has a peculiar leaden grey semi-metallic lustre.

The Diamond in its purest condition, is colourless and transparent; yet at times it is found coloured throughout

of almost every possible tint; it may thus become pale-yellow, deep-yellow, light bottle-green, yellowish-green, blackish-green, blue, red, brown, and black. Yellowish tints are the most common in "off-coloured stones:" next to yellow, greenish Diamonds are most numerous. Blue and red are very rare, and are highly valued as fancy stones. When the Diamond is between brown and black its transparency disappears, or is seen only at the angles.

Perfectly colourless Diamonds come from the mines of India, Brazil, the Cape, Borneo, and Australia. Perhaps about one-fourth of the crystals which come into the market are colourless; one-fourth of "pure water," with a flaw or spot of colour; and the remainder coloured.

The coloured Diamonds exhibit their lustre and clearness best when they are cut, especially the yellow ones, which by candle-light, are very brilliant.

Barbot is said to have succeeded, by means of chemical agents and a high temperature, in removing the colouring matter from the rough Diamond; but it seems scarcely possible that this can be accurate, though M. Barbot on the title-page of one of his works styled himself "Inventeur du Procédé de Décoloration du Diamant brut." Curiously enough, De Boot asserted 280 years ago, that his Imperial patron, Rudolf II., possessed a secret which enabled him to clear any Diamond of its flaws and colour.

Various devices have been resorted to by unprincipled dealers for deceiving the purchaser in respect to the colour of Diamonds. Thus, the yellow tint of many off-coloured Cape stones, has been corrected by painting them with a pale blue solution, or washing them with dilute violet ink. The effect is only temporary, and the trick is of course easily detected by placing the Diamond in spirit.

In many Diamonds the core is not pure, but shows blackish or greenish spots. This is more particularly the case in the green stones. Many Diamonds have also "feathers" and fissures, which materially modify the passage of light, and of course diminish the value of the stones.

Black Diamonds of great beauty are occasionally supplied by Borneo, which are so adamantine that ordinary Diamond-dust makes not the smallest impression upon them ; and they can only be ground or polished by using their own dust for the purpose. Of late black Diamonds have been much sought after.

Phosphorescence, &c.

Phosphorescence is produced not only by heat, but also by the action of light, and persists long after removal from the luminous source. The Diamond becomes phosphorescent under the influence of the sun's rays, or by insolation, and remains glowing for some time after removal from the sunshine, even when covered with cloth, leather or paper. It appears that this property was first recorded by Boyle in the year 1663.

The phosphorescence is most striking after the Diamond has been exposed to the *blue* or more refrangible rays of the spectrum ; under the red rays, or rays of low refrangibility it is much weaker. The author on one occasion exposed a fine orange-coloured Diamond of about 115 carats to the prolonged action of a powerful lime-light, and then removed it to a dark-room, when the phosphorescence was sufficient to light up the apartment. All Diamonds do not phosphoresce after exposure to light, but Diamonds of yellow colour seem peculiarly susceptible to luminous influences.

In Sir William Crookes's remarkable researches on radiant matter, he submitted the Diamond and other minerals to the effect of the molecular discharge in vacuum tubes connected with a powerful induction coil. "Without exception," he says, "the Diamond is the most sensitive substance I have yet met for ready and brilliant phosphorescence." A beautiful green Diamond in his collection emits a pale greenish light, and becomes almost as luminous as a candle-flame. Most South African Diamonds glow with a bluish light, but stones from other localities phosphoresce in various colours. Sir William Crookes finds that those Diamonds which phosphoresce most vividly under the electric discharge in a vacuum are such as become fluorescent on exposure to sunlight. He has also observed that when a Diamond is exposed to radiant discharge it gradually becomes brown or even black, in consequence of the surface becoming converted into Graphite.

It has been shown by Mr. G. F. Kunz, of New York, that a very slight amount of friction is sufficient to cause a Diamond, if clean and dry, to exhibit a phosphorescent glow of greater or less intensity. The friction may be effected on either wood, cloth or metal; but the best results were obtained by rubbing the stone on wood, in a direction across the grain.

One of the remarkable optical characters of the Diamond, as observed a short time ago by Sir William Crookes, is its transparency to the X rays. On the contrary, the glass which is used for fabricating imitation Diamonds is almost opaque to the Röntgen radiations; and this difference has consequently placed in our hands a new mode of distinguishing, with readiness and certainty, between false and genuine diamonds, and other gems.

The Diamond is a non-conductor of electricity—a fact which is the more remarkable as Graphite and Charcoal, substances absolutely identical with it chemically, are very good conductors. By friction, however, both in the rough and polished state, it becomes positively electric. When exposed to the intense heat of the electric arc, the Diamond swells up, becomes black, and is converted superficially into a form of Graphite.

Chemical Composition.

The chemical composition of the Diamond was not demonstrated completely until about forty-four years after Sir Isaac Newton's death (*b.* 1642—*d.* 1727). Notwithstanding the expressed conviction of Newton that the Diamond was combustible, a great contemporary, the Hon. Robert Boyle, desirous of putting the combustibility of the Diamond to the test, placed a Diamond in his crucible, and then subjected it to an intense heat without effecting his purpose. His death occurred in 1691; and three years afterwards the Grand Duke Cosmo III. induced the Academia del Cimento in Florence, to fix a Diamond in the focus of a large burning glass, and expose it to the solar beam. The experiment was performed by the Academicians Averani, and Targioni; and the experimenters saw the Diamond crack, coruscate, and finally disappear, without leaving behind any appreciable ash. In 1751, the Emperor Francis I., in the presence of the celebrated chemist Darcet, in Vienna, subjected Diamonds and Rubies, of the estimated value of £600, to the heat of a smelting furnace for four-and-twenty hours, when the Diamonds wholly disappeared, but the Rubies remained, not only uninjured, but more lustrous than before. The author in like manner has exposed

Burmese Rubies to very high temperatures, in order to see whether they might not be thus removed from their matrix of calcspar, without producing any appreciable effect upon them.

Many authorities in the scientific world turned their attention during the last century to the chemistry of the Diamond, and carried on experiments, to ascertain the exact nature of its composition. In the laboratory of M. Macquer on July 26th, 1771, a magnificent Diamond was burnt with the same result as that which the Emperor Francis had obtained twenty years previously in Vienna. As a flame was said to be seen surrounding the Diamond in Macquer's experiment, there could be no doubt that the mineral had actually undergone combustion—a fate which has befallen several hundreds of small Diamonds, burnt under the author's care in experiments performed in conjunction with Professor Pepper, both at the Royal Polytechnic Institution and at the author's establishment: in all cases the Diamond was practically consumed, leaving behind only an insignificant amount of ash in the form of a light bluish powder.

It appears that, notwithstanding the experiments in France which demonstrated the combustibility of the Diamond, a well-known jeweller of Paris, M. Leblanc came forward, and declared the Diamond to be indestructible in the furnace, though heat might be applied for any length of time. He stated in confirmation of his assertion, that he had often subjected Diamonds of his own to intense fire, to rid them of blemishes, and that they had never suffered the slightest injury from his treatment of them. Thereupon the two chemists, Darcet and Rouelle, demanded that he should make the experiment before them on the spot. He accepted the challenge, and taking some Diamonds, he enclosed them

in a mass of charcoal and lime in a crucible, and submitted them to the action of the fire, expressing himself confident that at the end of the trial he should find them uninjured. But alas! he had sacrificed his Diamonds, for on looking into the crucible after the three hours' trial, they had entirely disappeared. His colleagues, however, did not long enjoy their triumph, for M. Mitouard, another, jeweller, in the presence of the eminent chemist, M. Lavoisier took three Diamends, and having *closely packed them in powdered charcoal*, in an earthen pipe-bowl, submitted them to the test of fire, and when the bowl was removed and cooled, there lay the Diamonds in the centre of the powdered charcoal, untouched by the heat. Lavoisier was not convinced by the experiment, and it soon occurred to him that the conditions under which Mitouard's test was conducted might account for the difference of result. It was, indeed, soon discovered that the immunity enjoyed by the Diamonds of Mitouard, was due to the exclusion of the oxygen of the air from the Diamond by packing it in a substance of the same nature, in a state of fine division, by which means all the oxygen that was admitted attacked first the carbon, with which it combined. Lavoisier thus appears to have set the matter at rest; but it was not until 1814 that Sir Humphry Davy showed conclusively by quantitative experiments that the Diamond was practically nothing but pure carbon.

When a Diamond is burnt, with a free supply of oxygen or of atmospheric air, it is completely converted into the gaseous body known to chemists as *carbon di-oxide.* This carbon di-oxide, which is commonly called carbonic acid, resulting from the burning of the Diamond is identical with that which attends the combustion of

every fire and gas burner, or the decomposition of organic bodies, and which is exhaled in every breath we breathe.

One of the most beautiful, and at the same time, most conclusive of experiments, both as regards the combustibility and the composition of the Diamond, may be very simply performed as follows :—Fill a Florence flask with oxygen, into which pour three or four ozs. of lime-water, perfectly pellucid and clear. Through the stopper of the flask lead the two wires from a galvanic battery. Join the wires inside the flask by a *fine* coil of platinum wire, wound round a Diamond. Turn on the current: the platinum wire will glow white hot, the Diamond will burst into flame, and continue burning after the current is broken. The clear pellucid lime-water will become turbid and milky, owing to the carbonic acid produced by the burning Diamond forming, with the lime-water, carbonate of lime; and finally a sediment of this solid white carbonate of lime will be precipitated, while the flask, at the conclusion of the experiment, will be found to contain carbonic acid gas.

The temperature must be very high and somewhat protracted for the burning of a solid Diamond. A much lower degree of temperature, however, will be sufficient to burn Diamond dust, if the latter be spread out on a thin red-hot platinum plate, placed over a spirit lamp. Small Diamonds will burn in a short time, if put on a plate of the same metal, and if the flame of a spirit-lamp be directed by a blow-pipe under the plate.

When a Diamond is subjected to the sun's rays in the focus of a burning glass, or heated in oxygen gas, it gives out bright red sparks while burning. In order to observe how the Diamond suffered during the process of combustion, Petzholdt took two sharp-angled pieces of Diamond

and placed them before the oxy-hydrogen blow-pipe. From time to time they were removed in order to observe the action of the fire upon their form and substance; he thus detected that the heat had first acted on the sharp angles, thus rounding the Diamonds; and on the re-application of the heat, he observed that the Diamonds soon split up in pieces, and lost both their transparency and lustre. He could not detect any evidence of melting on the surface of the burning Diamonds; but on removing them from the fire, they assumed a leaden-grey color, due, no doubt, to superficial conversion into Graphite. Lavoisier also noticed that on exposing the Diamond to intense heat, black spots appeared on it, then disappeared, and re-appeared. Guyton de Morveau confirmed these statements. He consumed a Diamond in oxygen, by means of a burning-glass. First he saw on that corner of the Diamond which was in the exact focus of the lens a black point; then the Diamond became black and carbonized. A moment after, he saw clearly a bright spark, twinkling as it were on the dark ground; and when the light was intercepted, the Diamond was red, and for a time transparent. A cloud now passed over the sun, and the Diamond was more beautifully white than at first; but as the sun again shone forth the surface assumed a metallic lustre. Up to this point the Diamond had sensibly decreased in bulk, not being more than a fourth of its original size. The experiment was suspended for a day or two. On its resumption, the same phenomena occurred, but in a more marked degree; subsequently the Diamond entirely disappeared. At the conclusion of his treatise, in which these experiments are detailed, he says, "If it were possible, while the Diamond is burning, to collect the black substance which covers the surface, the Diamond would

indisputably be shewn to be carbon:" that is to say, it would be recognized under the more generally known form of graphitic carbon.

Fourcroy corroborated Guyton de Morveau. He placed two small Diamonds in a capsule, under a muffle, heated them, arrested the burning, suffering the half-consumed bodies to cool, and on removing the muffler he found them quite black, as though they had a covering of soot, which he removed by rubbing with a piece of paper, on which was left a black mark.

To Guyton de Morveau we are indebted for describing an interesting experiment made by Clouet in 1798, which consisted in converting iron into steel by heating it with the Diamond. Since steel is a combination of iron and carbon, this indirectly establishes the composition of the gem. Pepys, in the early part of this century, also effected the carburisation of iron-wire, by heating it with Diamond-dust by means of a galvanic battery. The experiment has been repeated in various ways by other experimentalists in modern times, notably by Margueritte in France, and Hempel in Germany, and by Professor Roberts-Austen in this country. The last named chemist used pure electrolytic iron which was heated in vacuo by means of an electric current, so as to expel all occluded gas: small Diamonds were then introduced in contact with the iron, and the metal again connected with the dynamo, when fusion occurred and the molten metal combined with the substance of the Diamond.

The brothers Rogers, two American scientists of great reputation, asserted that with potassium chromate and sulphuric acid at from 180° to 230° the Diamond is oxidized into carbonic acid. Jacquelain and Despretz used very powerful galvanic batteries, and found that a

Diamond, heated in an atmosphere of carbonic acid, by means of the oxy-hydrogen blow-pipe, gradually disappeared without any sign of softening. Morren has studied the behaviour of the Diamond when exposed to high temperature in various gaseous media.

Gassiot experimented on the Diamond by strong galvanic currents between carbon points, demonstrating that in burning Diamonds, uncrystallized black carbon is first produced, which at a very high temperature, burns off into carbon di-oxide; that many rough Diamonds possessing a metallic lustre become leaden-grey, and that the blackish spots, adhering to the surface of some, may be got rid of by great heat.

Some very notable experiments on the action of heat upon Diamonds, were made some years ago, by the late Professor Gustav Rose, of Berlin. Enclosing the stones in strong glass vessels, from which the air had been exhausted, he subjected them to the intense heat of the electric arc produced by Siemens's powerful machines. Air being thus excluded, the Diamonds could not be consumed, but it was remarkable that they gradually became encrusted with a dark coating of graphitic carbon, resembling blacklead.

That the Diamond could be converted into Graphite when heated in the electric arc was clearly demonstrated as far back as 1847 by Jacquelain; but quite recently M. Moissan, by means of his electric furnace, has carefully studied the phenomenon, and has found that the resulting Graphite occurs in irregular crystalline forms. At a very exalted temperature he has been able to volatilize carbon.

Professor Dewar, in his remarkable researches on liquid oxygen at the Royal Institution, has shewn that if a Diamond be strongly heated, and then suddenly thrown

into the liquid, it burns with great brilliancy, and yields by its oxidation, carbonic acid, which at the low temperature of the condensed oxygen forms a solid snow-like substance.

Although chemists concluded long ago that the Diamond was a natural form of carbon, it remained for Dumas, the eminent French chemist, in conjunction with Stas, of Brussels, to undertake about the year 1840, some refined researches, which definitely fixed with extreme precision the chemical composition of the Diamond. M. Friedel in Paris, and Sir Henry Roscoe in this country, have also investigated the subject, and the chemistry of the Diamond is thus placed beyond dispute.

THE ORIGIN OF THE DIAMOND.

Numerous hypotheses, some extremely ingenious, have been suggested by scientific men to explain the origin and formation of the Diamond. Some have supposed that it has been formed immediately from carbon or carbonic acid by the action of heat; others that it has been produced from the gradual decomposition of vegetable matter, with or without heat, or that it is formed from the decomposition of gaseous hydro-carbons; whilst others again believe that it has been crystallized from a molten metal like iron.

Leonhardt held that the Diamond was formed by the sublimation of carbon in the depths of the earth; Parrot that it was produced by the action of volcanic heat upon small pieces of carbon; Göbel, that pure carbon has been separated from carbonic acid by electricity in the presence of reducing agents, such as magnesium, calcium, aluminium, silicon and iron; Hausmann, that it is by the action of

electricity, especially in the form of lightning, upon carbonic acid, that its decomposition is effected; and he quotes the statements of the Ancients, "that in those mines where the largest number of Diamonds were found, were so-called thunder-bolts."

Among those who have supported the vegetable origin of the Diamond, is Newton, who believed it to be a coagulated fat, or oily body, of vegetable origin. Jameson and Brewster advanced similar views; and Petzholdt also decided for the vegetable origin, basing his conclusions mainly on the microscopic study of the residual ash left when a Diamond is burnt. In view of our present knowledge it is interesting to read what the great chemist, Liebig said on this subject: "Science affords us no analogy, except that of decomposition and decay, for the formation or origin of the Diamond. We know that it does not owe its origin to fire; for a high temperature and the presence of oxygen are incompatible with it on account of its combustibility: on the contrary, there is undeniable ground for supposing that it was formed in the wet way; and the decomposition process alone helps us in our attempts to solve the mystery of its origin. What kind of vegetable substance, rich in hydrocarbons, the decomposition of which gave rise to the Diamond, and what particular conditions had to be fulfilled in order to crystallize the carbon, are not at present known to us; but this much is certain, that the process must have been exceedingly gradual, and in no way hastened by a high temperature; otherwise the carbon would not have become crystallized, but would have separated itself as a black powder."

Wöhler also was of opinion that the Diamond did not originate at a high temperature, or at least not by fusion.

The late George Wilson, of Edinburgh, held the view that the Diamond, might be formed from anthracite, or steam-coal, without a change from the solid state.

Dana, the venerable American geologist, regarded the Diamond as a product of the decomposition of organic matter, under the operation of various agents of metamorphism. The late Prof. Carvill Lewis sought the origin of the South African diamonds in the decomposition of carbonaceous shales by the action of certain volcanic materials thrust through them. According to the late A. Favre the paragenesis of the Brazilian Diamonds suggests the presence of chloride of carbon as the substance which, by its decomposition, yielded the pure carbon. Gannal advocated the view that it results from the decomposition of carbon disulphide.

Opposed in some degree to all the above theories, is the view of Simlar, of Breslau, that the Diamond is the result of the crystallization of carbon from a liquid solution. According to his theory, carbonic acid collected, in far away time, in a number of cavities, and was liquefied under great pressure; it then dissolved some pre-existing form of carbon; and subsequently the carbonic acid became gradually dissipated through fissures and clefts, and the crystallization of the dissolved carbon began. Supposing the pressure suddenly to abate, and a quick evaporation of the liquid to occur, a considerable mass of compact black Diamond might be formed, such as is known in commerce as carbonado, or carbon.

There has been a suspicion in the minds of many chemists that the origin of the Diamond may be possibly sought in the slow decomposition of certain gaseous hydrocarbons. Thus, Chancourtois suggested that emanations of hydro-carbons from fissures in the earth might suffer

partial oxidization, the hydrogen being converted into water and part of the carbon into carbonic acid, while the residual carbon might be deposited in a free state, just as sulphur is set free on the oxidation of emanations of sulphuretted hydrogen. Rousseau has obtained black Diamond by heating acetylene in the electric furnace.

It is well known to metallurgists that molten iron will dissolve carbon, and that the excess beyond that which forms cast-iron will separate, on cooling, in the form of crystalline plates of graphite, known to the iron-workers under the curious name of "kish." M. Moissan has shewn that the physical condition which the carbon assumes is dependent to a large extent on the pressure to which it is subjected at the time of consolidation, and that under enormous pressure it is liberated in the form of Diamond. This discovery has given fresh interest to some observations made in Edinburgh about the year 1880 by Dr. Sydney Marsden. He found that molten silver dissolved carbon, and that this separated, on cooling, partly as amorphous, or un-crystallized matter, and partly in the crystalline states of Graphite and Diamond. The use of the electric furnace has enabled M. Moissan to confirm and extend these observations.

In order to secure the separation of carbon in the adamantoid form, Moissan saturated the iron with pure carbon, and suddenly cooled the mass by plunging it into a bath of molten lead, when the exterior consolidated as a crust around the molten iron: this then slowly solidified, and by its expansion in cooling an enormous pressure was secured. The experiment has been successfully repeated by several chemists in this country.

But though Diamonds have thus been artificially produced they are of such minute size, being merely

microscopic grains, as to be utterly destitute of commercial value. Nevertheless they are of great scientific interest as suggesting a possible mode of origin for natural Diamonds. Indeed Sir W. Crookes believes that the South African Diamonds may have been formed in a somewhat similar way from deep-seated masses of metallic iron.

In connection with this subject mention should be made of some remarkable discoveries of diamantoid carbon in meteoric iron. On September 22nd, 1886, three meteorites, or sky-stones, fell near Novo Urei, in a remote part of South-Eastern Russia. These strange visitants from space were subjected to scientific examination by MM. Jerofeiff and Latchinoff; and in one of the meteorites, carbon was found in a diamantoid condition, forming about one per cent. of the entire weight of the stone. It is true that this carbon was rather of the character of carbonado, the black variety of Diamond, to be subsequently described; but still the presence of any kind of Diamond in an aerolite is a fact of surpassing scientific interest, while even those who are not scientific, will not fail to appreciate the importance of finding this remarkable mineral in a heaven-dropped stone.

Still more remarkable results attended the examination of the famous meteorites of Canyon Diablo, in Arizona. In 1890 numerous fragments of iron, some weighing as much as half a ton, were found scattered over the surface of a plain in Arizona, and were regarded by a prospector as representing the outcrop of a lode of metallic iron. Their meteoric character was however recognized by the late Dr. A. E. Foote, of Philadelphia; and in cutting through one of the masses, to form a slab, he discovered certain hard grains, which Professor G. A. Koenig, on careful examination, pronounced to be veritable Diamonds! This remarkable

discovery has since been amply confirmed by many scientific observers in various parts of the world.

On dissolving the Arizona meteorites, by means of acids, the Diamond may be liberated from their imprisonment in the iron, since they resist all solvent action. If, now, as pointed out by Sir W. Crookes, these masses of iron, as they lay exposed upon the ground had been gradually attacked by atmospheric agencies, and eaten away as so much rust, all the metal would have disappeared, while the Diamonds set free would have been found scattered over the soil, and might then have been naturally regarded as terrestrial minerals. Hence the startling suggestion is forced upon us that some of the Diamonds found in sands, gravels, and other superficial deposits on the surface of the earth, especially where only a single Diamond is now and then picked up—may, after all, have been originally dropped from the sky in the shape of meteoric matter, and be therefore literally a direct gift from Heaven!

DIAMOND.

Composition	Pure Carbon.
Specific Gravity	3·51 to 3·52.
Hardness	10.
System of Crystallization ...	Isometric or cubical.
Common Forms of Crystals ...	Octahedron, Rhombic Dodecahedron, Hexakis Octahedron, &c.

CHAPTER II.

AFRICAN DIAMONDS.

IN dealing with the geographical distribution of Diamonds, the stones of each locality will be described in a separate chapter, and the several localities will be taken in their alphabetical order. It is not, however, a mere alphabetical accident which places Africa at the head of the diamond-yielding localities, for during the last thirty years the yield of the South African mines has been without a parallel in any other part of the world, and probably without a parallel at any period of the world's history.

Although South Africa has risen as a diamond-producing locality within the recollection of the present generation, much evidence may be adduced in support of the view that Diamonds were known and worked there at a very remote period. Thus, the Monastery Mine, in the Orange Free State, though unknown in modern ages until a few years ago, had evidently been previously worked and abandoned—the ancient workings probably going back to prehistoric times. Implements wrought in stone and bronze have been discovered in the deserted mine, associated with human skeletons; and it is hoped that the scientific examination of these relics by competent experts may throw light upon the date of the old workings. It may be added, that Mr. W. H. Penning also believes from his discoveries of stone implements at Kimberley that the

Diamonds of that district were known to, and worked by, a prehistoric people. My own view is that South Africa may have supplied the Diamonds used by Moses in the High Priest's breast-plate, as well as the precious stones which the Queen of Sheba presented to King Solomon. Moreover, the resemblance of the Diamonds of the Monastery Mine to Indian stones raises the suggestion that this may have been the original source of many so-called Indian Diamonds,—a suggestion which receives support from the fact that the present yield of the mines of India is extremely small.

It appears certain that the presence of Diamonds in South Africa was known to European colonists in the middle of the last century; and the words "Here be Diamonds" are to be seen inscribed across our modern territory of Griqualand West, in a Mission Map of 1750. The old Dutch residents of Cape Town appear to have been quite astir about the matter on several occasions, but years passed on and the ancient rumours died away.

Rather more than thirty years ago, it happened that a child of Mr. Jacobs, a Dutch farmer settled at the Cape, amused himself by collecting pebbles from the neighbourhood of the farm, near Hopetown At first sight there might seem nothing remarkable in this circumstance, for pretty pebbles were to be had in plenty near the neighbouring river. One of these stones, however, was sufficiently bright to attract the keen eye of the mother, though she regarded it simply as a curious pebble, and gave it little more than a passing glance. Some time afterwards a neighbouring boer, Mr. Schalk van Niekirk. visited the farm, and, knowing him to be curious in such matters, Mrs. Jacobs called his attention to the bright transparent stone. So little heed, however, had been given

to the pebble, that when wanted it was nowhere to be found; and it was only after diligent search that it was at last discovered outside the house, just where it had happened to fall when the child had last used it as a plaything. Van Niekirk was sorely puzzled with the stone, yet thinking that it might possibly have some value, offered to buy it of Mrs. Jacobs. The good woman laughed at the notion of selling so common a stone, and at once gave it to the enquiring farmer.

Just then it chanced that Mr. J. O'Reilly was returning from an expedition in the interior, and to him Van Niekirk confided the stone, with a request that he would endeavour to ascertain its nature from any trustworthy mineralogist whom he might meet. By O'Reilly the stone was taken to the town of Colesberg. Few people at this time believed that Diamonds occurred in South Africa, and when O'Reilly cut his initials on a window-pane of the hotel at Colesberg, it was supposed that he was using simply a fragment of common quartz or rock crystal.

Notwithstanding the ridicule of the bystanders, O'Reilly clung bravely to the notion that he had got a Diamond and he afterwards showed the stone to Mr. Lorenzo Boyes, the Clerk of the Peace of the district. Mr. Boyes knew that his friend, Dr. G. W. Atherstone, of Graham's Town, was an excellent mineralogist; and, anxious to get his opinion, he sent the enigmatical stone through the post, accompanied by an explanatory letter. When it reached Graham's Town, the good doctor had some difficulty in deciding what the curious pebble could be, and he consulted Bishop Ricard. After carefully examining its physical characteristics, after testing its degree of hardness, its density, and its behaviour when subjected to optical tests by means of polarized light, they were bold enough to

pronounce it a genuine *Diamond!* This was in March, 1867, and the Universal Exhibition in Paris was about to open in the spring. What more appropriate, the doctor thought, than to send this stone to Paris? Here was the greatest novelty the Colony could exhibit—the first African Diamond of modern days!

Dr. Atherstone accordingly communicated his suggestion to the Colonial Secretary, the Hon. R. Southey, and in consequence of this suggestion the Diamond was duly conveyed by steamer to Cape Town, where it was examined by the French Consul, M. Heriette, who having confirmed Atherstone's determination as to the stone, forwarded it in due course to Paris. There it stood during the whole summer, and having been examined by *savants* of all nations, it was purchased at the close of the Exhibition by Sir Philip Woodhouse, at that time the Governor of the Colony, for the sum of £500. The weight of this Diamond was $21\frac{3}{16}$ carats.

Such is the history of the discovery of the first Cape Diamond of modern times. O'Reilly soon afterwards found a second stone weighing $8\frac{7}{8}$ carats, which realised £200. This man may therefore, be justly regarded as the pioneer in this century of the great Diamond-mining industry of South Africa.

Mr. Van Niekerk, who also played an important part in the early history of the Diamond fields, shortly afterwards obtained from a native a Diamond weighing $83\frac{1}{2}$ carats, which he sold in Hopetown for £11,200. This stone when cut, became known as the "Star of South Africa." Other discoveries, rapidly following one another, led to the modern development of the great Diamond-fields of South Africa.

Until the discoveries of Diamonds directed attention to this district, scarcely anything was known of its geological character. Stripped of all superficial deposits, the solid framework of the country consists of rccks belonging to that great geological series which, from its conspicuous occurrence in the "karoos" or vast plains in the interior, has received the name of the *Karoo-formation.* For the most part it consists of shales and sandstones, which represent old deposits of mud and sand, now hardened and altered, but originally thrown down as sediment in a vast fresh-water lake Africa is still famous for its large sheets of inland water; but the lakes in which the karoo beds were deposited are of great geological antiquity, probably corresponding roughly in time with the period at which the New Red Sandstone of this country was formed. Although for the most part destitute of fossils, the karoo strata are in places rich in organic remains, the most notable being the relics of extinct reptiles, which must have lived near the margin of the waters which deposited the ancient sediment.

In addition to these remains of extinct animals, we find in many of the karoo-beds numerous vegetable relics, in some places in the form of fossil-wood, while elsewhere the wood has been converted into coal. The coal seams of the karoo series occur especially in the upper part of the formation, and notably at the Stormberg. By the action of heat, some of the Stormberg coal has been converted into anthracite or steam-coal, a variety of fossil-fuel peculiarly rich in carbon; whilst the occurrence of graphite, or "black-lead," in some of these beds, has been regarded as the result of further modification of the coal. As graphite is but an impure variety of carbon, whilst we know that the Diamond is simply a pure crystallized form of the same element, some geologists have been tempted to

speculate as to the possible effects of further metamorphosis upon the graphite, and have thus dimly seen in the vegetable fossils of the karoo formation the ultimate origin of the South African Diamonds. Quite recently Dr. Friedländer has suggested, on experimental evidence, that the Diamonds may have been formed by the action of a molten silicate, like olivine, on graphite; and the late Prof. Carvill Lewis held that the South African Diamonds had probably been formed by the action of an olivine rock, or peridotite, on the carbonaceous matter of the karoo shales. Many other observers, however, are disposed to refer the Diamonds to a much deeper subterranean origin.

In certain places the lacustrine shales and sandstones of the karoo-formation are cut through by dykes or veins of various eruptive rocks, known popularly as "trap;" whilst in other places similar igneous rocks are spread out in sheets, intercalated between the sedimentary strata. Varying considerably in their characters in different localities, some of them exhibit a vesicular texture, and contain in their bubble-like cavities kernels of Chalcedony, Agate, Jasper, and other siliceous minerals. By the disintegration of such rocks, the hard Agates and kindred stones are set free, and carried down as pebbles by the rivers. Indeed the shingle of the Orange and Vaal Rivers has long been famous for the beauty of its Agates and other pebbles. In addition, however, to these attractive chalcedonic pebbles, the shingle contains a great variety of other minerals, among which there is one of paramount interest—the Diamond itself. It was in the agate-bearing gravels of the Vaal and Orange Rivers that the Diamond washer originally established his "river-diggings."

The search for Diamonds along the Vaal River commenced in 1868. According to Mr. R. W. Murray, the

CAPE DIAMOND in Matrix.

[illegible] the possible effects of [illegible] metamorphosis [illegible] lite, and have thus dimly seen in the [illegible] of the karoo formation the ultimate [illegible] South African Diamonds. Quite recently [illegible] suggested, on experimental evidence, that [illegible] Diamonds may have been formed by the [illegible] like division of graphite; and the [illegible] Carvill Lewis held that the South African Diamonds had [illegible] been formed by the action of an olivine rock, or peridotite, on the carbonaceous matter of the karoo shales. Many other observers, however, are disposed to refer the Diamond to a more deep-seated terranean origin.

In certain places the karoo shales and sandstones of the karoo-formation are cut through by dykes or veins of various eruptive rocks, known popularly as "trap," whilst in other places similar igneous rocks are found out in sheets, intercalated between the sedimentary strata. Varying considerably in their characters in different localities, some of them exhibit a vesicular texture, and contain in their bubble-like cavities kernels of Chalcedony, Agate, Jasper, and other siliceous minerals. By the disintegration of such rocks, the hard Agates and kindred stones are set free and carried down as pebbles by the rivers. Indeed the shingle of the Orange and Vaal Rivers has long been famous for the beauty of its Agates and other pebbles. In addition, however, to these attractive [illegible] pebbles, the [illegible] contains a great variety of other [illegible] [illegible] possess considerable interest [illegible] Diamond [illegible]. It was in the [illegible] gravels of the Vaal and Orange Rivers that the Diamond washer originally established [illegible].

The [illegible] for Diamonds along the Vaal River [illegible] [illegible] According to Mr. [illegible] W. Murray, the

CAPE DIAMOND in Matrix.

earliest Diamond-searching party was formed in Bethulie under Mr. J. B. Robinson, and established themselves near Hebron. Then followed a party from Natal, who set to work with intelligence—systematically digging the soil from the banks of the Vaal, and washing it in a cradle for Diamonds just as they might cradle it for gold. Another party from Kaffraria established themselves at Klipdrift, on the other side of the Vaal. Klipdrift was afterwards called Barkly. Still later, another contingent of fortune-hunters were led to dig near a hill named Pniel, and thus founded the famous Pniel workings opposite Barkly West.

Although the river-diggings declined in importance after the discovery of the "dry-diggings," they will always be of great interest from the fact that they represent the earliest workings in the South-African Diamond-districts in modern times, and they still produce the finest quality of Diamonds. The river-drifts are worked in very primitive fashion, but the stones realize about 40 per cent. more than those obtained from the Kimberley mines. It has been suggested that the materials of the Vaal gravels have been brought down from the head waters of the river, but it seems equally probable, that the Diamonds may have been introduced into the gravels at some other part of the course of the stream. In fact, the late Mr. Tobin, the pioneer of the author's Diamond Expedition Party, in 1870, showed that the source of the Vaal is in sandstone, and that the agate pebbles are not to be found in the stream until after it has traversed a distance of several miles.

It was soon found that the Diamond-bearing gravels are not confined to the present bed of the river. Terraces of similar gravels run along the margins of the river, at a considerable elevation, and many of the larger Diamonds are found in these old high-level gravels. But, in addition

to the deposits along the margins of the river valleys, there are superficial accumulations of gravel, sand, and clay widely spread over a vast area of the country. These wide-spread deposits of drift conceal the surface, rising up the sides and covering the summits of the little hills which form so marked a feature in the scenery of the Diamond districts. These hillocks, or knolls, which in some cases attain to a height of upwards of 100 feet, are known locally as *kopjes*, and the discovery of Diamonds on some of these *kopjes* led originally to the establishment of the famous "dry diggings."

The most remarkable group of Diamond mines in the world is formed by the celebrated workings known as Kimberley, De Beers, Du Toit's Pan, Bultfontein, and Wesselton Mines. The origin of these mines is of great interest. A Dutch Boer, named Van Wyk, who occupied a farm house at Du Toit's Pan, was surprised to find Diamonds actually embedded in the walls of his house, which had been built of mud from a neighbouring pond. This led to examination of the surrounding soil, wherein Diamonds were found. On deepening the digging, Diamonds were still brought to light; nor did they cease when the bed-rock was at length reached. Such was the origin of the famous Du Toit's Pan.

The estate known as Vooruitzigt was the property of Mr. De Beer, and after Diamonds had been discovered at Du Toit's Pan and Bultfontein, workings were commenced there with such success that a mining camp soon sprang up, known as Old De Beers. In July, 1871, a fresh centre of discovery was reported at a small hill or *kopje* situated at only about a mile from De Beer's, where a young man, having taken shelter from the sun under a mimosa-bush, accidently found a Diamond

by scraping the soil with his knife. A rush naturally ensued, and the locality became known as "Colesberg Kopje," or the "New Rush," while the surrounding town, which to meet the wants of the new comers sprang up with mushroom-like celerity, received the name of Kimberley, in compliment to the Earl of Kimberley; at that time H.M.'s Secretary of State for the Colonies. The town of Kimberley lies between the workings of the Kimberley mine and De Beers. Bultfontein, one of the earliest mines, originally belonged to Mr. Du Plooy, who sold it in 1870.

Early in 1891 Diamonds were discovered on the farm known as Benaudheidfontein, in the district of Kimberley, and as this farm was the property of Mr. J. J. Wessels, senior, the mine came to be known as the Wesselton.

The site of each Diamond mine is a more or less circular area, surrounded by horizontal shales, the edges of which are slightly turned upwards round the margin of the area. This evidently suggests that the shales, which were originally horizontal, have been pushed aside by the intrusion of matter forced from below. Indeed, all geologists now maintain that the Diamond-bearing rock is of eruptive origin, being probably to some extent a kind of volcanic mud, and has passed upwards in columnar pipes, and been thrust through the surrounding shales.

The upper portion of each pipe was found to consist of the reddish sandy soil of the country, and below this came a layer of calcareous tufa, or a light deposit of carbonate of lime; and it was by no means uncommon to find Diamonds adherent to this tufaceous rock. At a still lower depth, the main contents of the pipe were reached, which consisted in large part of an altered volcanic rock, in places much broken up, and passing into a breccia. The

upper part of the rock was oxidised by meteoric agencies, and was known, from its color, as "yellow earth." This passed downwards into the "blue ground," the colour of which suggests that the iron present has not reached the condition of peroxide.

The exact nature of the blue earth puzzled petrologists for a long time; but the rock was carefully examined by Prof. Nevil Story-Maskelyne, and afterwards on the Continent by many petrographers, especially by Cohen and Stelzner in Germany, and by Fouqué and Lévy, in France; and more recently in this country by Prof. Bonney and Miss Raisin. The late Prof. Carvill Lewis suggested that the blue Diamond-bearing rock should be distinguished under the name of *Kimberlite.* The base of the rock is generally a soft mineral, soapy to the touch, and of green or bluish color. By the late Prof. A. Stelzner, of the Mining Academy of Freiberg in Saxony, the blue matrix was regarded as an altered olivine-diabase; the whole rock being more or less serpentinized. The diamantiferous material in the pipes is however, not a distinct species of rock, but a mixture—partly of matter erupted from below and partly of altered sedimentary rocks. It contains angular fragments of shale, associated with various minerals, such as pyrope, or chrome-garnet, chrome-diopside of bright green colour, enstatite, mica, vaalite, zircon, cyanite, hornblende, barytes, magnetite, chromite, titaniferous iron-ore, perofskite, etc.

But the only minerals that attract the miner's attention are the Diamonds. These are sparkling pretty freely through the "stuff;" sometimes as beautifully formed crystals, but frequently as mere fragments and splinters. They are said to be most abundant in the neighbourhood of doleritic dykes, but their distribution is very irregular; in one claim they may be richly disseminated, whilst in the neighbouring

claim they are but sparsely scattered through the rock. Microscopic crystals of Diamond are disseminated through the blue earth. Each matrix is said to yield Diamonds easily distinguished from those of other pipes, so that buyers on the field can generally tell, on looking at a stone, from which locality it has been obtained. These local peculiarities suggest that the stones have been formed in or near the centres where they are now found, though probably at great depths. In support of this view, it has been pointed out that most of the crystals are sharp at the edges, and exhibit no signs of abrasion, such as we might expect to find had they been transported far from their original site; but on the other hand, a large proportion of the crystals have evidently been shattered, and exist now as mere fragments, showing that the rocks have suffered great disturbance, probably during their projection to the surface from some deep-seated source.

It is interesting to note the nature of the rocks through which the volcanic material must have forced its way upwards. Beneath the red soil of the country is a decomposed basalt, and this is followed by black carbonaceous shales, dipping slightly to the north. The shales are from 200 to 250 feet in thickness, and it was suggested by the late Prof. Carvill Lewis, that the Diamonds may have resulted from the action of the olivine rock on the carbon of these shales. Beneath the shale is a bed of conglomerate, which rests upon an amygdaloidal olivine-diabase, often described as a melaphyre, and representing an old lava-flow, about 400 feet thick. The rock beneath this ancient lava is a quartzite of great but undetermined thickness.

Igneous dykes penetrate these rocks almost vertically. One of the most interesting of these dykes is the large mass in De Beers' mine, known as the "Snake." According

to Stelzner this rock is a pikrite-porphyry, much altered, and he believes that, though destitute of Diamonds, it was derived from the same subterranean source whence the blue earth took its rise.

The volcanic material rising from below, and bringing with it the Diamonds, ascended the pipes; but these were not all filled at the same time, nor was the blue earth of one pipe due to a single ascent of the material. Thus both in De Beers' and in Kimberley the "blue" of the west side is unlike that of any other part of the mine; it carries but few Diamonds and these present distinctive characteristics.

An ingenious hypothesis regarding the origin of the Diamond-bearing pipes and their contents has recently been enunciated by Sir William Crookes, who has lately returned from a visit to South Africa. He suggests that a solution of the perplexing problem as to the genesis of the South African Diamond may be readily found in the assumption that they have been formed from deep-seated masses of metallic iron in a molten condition, under enormous pressure and at a temperature so high as to be comparable to that of our electric furnaces. This molten iron held carbon in solution, and on solidifying under pressure the carbon would crystallize out as Diamond, just as it does in M. Moissan's experiments; only in nature the pressure might be vastly greater than in our laboratories and the process of cooling might be continued through ages of time, so that large crystals would be produced by natural means, whereas the crystals formed in our laboratory experiments are mere microscopic specks. If water, passing downwards, gained access to the heated materials, it would give rise to vast volumes of steam and other gaseous products, which rushing upwards could rend

the rocks, and so force open the channels which we recognize as the "pipes." The vapour rushing up these pipes might tear the shales and other rocks forming the walls, and thus give rise to fragmentary materials to be caught in the uprising pasty magma, producing as it cooled a brecciated mass. The pipes have thus become filled with a medley of materials, partly brought up from great depths, and partly due to the disintegration of the local rocks. But the Diamonds which give supreme value to the breccia have been formed in a deep-seated laboratory under the pipes, where carbon has crystallized from a saturated bath of iron, under prodigious pressure, and with inconceivable slowness.

In the early days of Diamond-mining in South Africa, the ground in these volcanic necks was worked as quarries, or open casts, and the material was hauled up by means of aerial wire ropes. Much inconvenience however was experienced as the diggings grew deeper, especially by the heavy falls of the surrounding shales, or "reef," which tended to slip in large masses into the workings. Moreover, the shales contained iron-pyrites, which occasionally ignited spontaneously, with disastrous results.

An entirely different system of working was therefore introduced at the Kimberley Mine, and this was soon followed at De Beers. Shafts were sunk at a convenient distance from the pipes, and successive galleries driven into the Diamond-bearing ground, as in the ordinary system of underground mining. The rock is brought down by drilling and blasting, and is run in trucks to the bottom of the shaft, up which it is hoisted in skips running on steel rails and worked by a steam winding-engine. The mines are fitted with all modern improvements, such as electric lamps and telephones connecting the different centres of work.

Arrived at the surface, the blue earth is conveyed to a platform of considerable altitude, from whence it is allowed to fall to the ground below. By this means the earth is broken up and crushed until the process has reduced it down to the size of a walnut, or less. It is then searched for large diamonds, and after these have been abstracted the stuff is gravitated through a machine consisting of six plates, each of which is covered with a layer of fat. In passing over these plates the diamonds are retained by the fat, to which they adhere, whilst the refuse is rejected and passed through the machine. So reliable is this "separator" in its working that we have, on the authority of Mr. C. D. Rudd, who has just returned from South Africa, the remarkable statement that 90 per cent. of the diamonds contained in the blue earth are found on the first plate, and he has never known of one being found below the second plate.

It is estimated that every load (a load weighs about 1,600 pounds) of blue ground from the Kimberley mine yields on an average from one and a quarter to one and a half carats of Diamonds; from De Beer's mine, one and a fifth to one and a third carats; from Du Toit's Pan one-sixth to one-fifth carat; and from Bultfontein only one-fifth to one-third of a carat.

The mines of De Beers, Kimberley, Du Toit's Pan, Bultfontein and Wesselton are practically under the control of the powerful combination known as "De Beers Consolidated Mines, Limited." This Company, of which the Hon. Cecil Rhodes is Chairman, has a capital of £3,950,000.

In order to prevent the theft of Diamonds at the mines, the native kaffirs or "boys," employed at the Kimberley mines are confined in an enclosed village, or

CRYSTAL OF YELLOW CAPE DIAMOND.

[illegible] surface, the blue earth is conveyed to [illegible] considerable altitude, from whence it is [illegible] the ground below. By this means the [illegible] and crushed until the process has reduced [illegible] of a walnut, or less. It is then searched [illegible], and after these have been abstracted [illegible] passed through a machine consisting of six [illegible] of which is covered with a layer of [illegible] [illegible] plates the diamonds are retained by the [illegible] adhere, whilst the refuse is rejected and [illegible] of the machine. So reliable is this separation [illegible] that we have, on the authority of Mr. C. [illegible] has just returned from South Africa, the [illegible] statement that 99 per cent. of the diamonds [illegible] the blue earth are found on the first plate. [illegible] never known of one being found below the [illegible] plate.

It is estimated that every load (a load weighs about [illegible] pounds) of blue ground from the Kimberley mine [illegible] an average from one and a quarter to one and a [illegible] of carats of Diamonds; from De Beer's mine, one and a [illegible] and a third carats; from Du Toit's Pan one-sixth to one-fifth carat; and from Bultfontein only one-[illegible] to one-third of a carat.

The mines of De Beer's, Kimberley, Du Toit's Pan, Bultfontein and [illegible] are practically under the control of the powerful combination known as "De Beers Consolidated Mines, Limited." The Company, of which the Hon. Cecil Rhodes is Chairman, has a capital of [illegible].

In order to prevent the theft of Diamonds at the [illegible] the Kaffirs or "boys," employed at the [illegible] are confined in an enclosed village, or

CRYSTAL OF YELLOW CAPE DIAMOND.

"compound," and the strictest supervision is exercised over them. The Diamond trade is regulated on the fields by the "Diamond Trade Act," known commonly as the "I.D.B. Act," its object being to prevent Illicit Diamond Buying. But, notwithstanding its stringency and the severity of the punishment accorded by the Special Court, the I.D.B. trade still flourishes.

One of the most interesting features in the Diamond production of South Africa is the large number of stones of unusual size which have been brought to light. Among those found in the river washings attention may be called to the famous "Stewart," which was found in 1872, at Waldeck's Plant, on the Vaal River. It is a Diamond of light yellow colour, beautifully crystallized, and weighed in its rough state 288⅜ carats, or nearly two ounces troy.

One of the finest South African Diamonds ever discovered was found on February 12, 1880, in a claim at Kimberley, belonging to Mr. Porter Rhodes. It is true that in weight it has been exceeded by many other stones, but in purity of colour it has very few rivals. It weighs 150 carats, and placed by the side of Cape stones, having a slight tendency to yellowish tints, it seems to present the faintest possible shade of blue. This magnificent "blue-white" Diamond, which was valued by its owner at £200,000, was publicly exhibited at Streeter's Museum in Bond Street.

Stones weighing over an ounce (151.5 carats) are by no means unfrequent at Kimberley. The largest Diamond ever found in either of the mines at Kimberley was a noble octahedral crystal from De Beer's weighing in the rough 428½ carats. This stone was sent to the Paris Exhibition of 1889, where it was cut to a brilliant weighing 228½ carats. It is known as the "Victoria."

At Jagersfontein, in the Orange River Free State, a Diamond of 209¼ carats was discovered, and it is said that this magnificent stone was purchased from a kaffir by an illicit Diamond buyer for the absurd sum of £15. A Diamond weighing over 600 carats, but very impure, was unearthed some years ago at these diggings, and the same mine has since yielded the largest Diamond ever recorded. This stone, known as "The Excelsior," weighed in the rough 970 carats, and is now being cut at Amsterdam. A figure of the stone in its rough state forms the tail-piece appended to this chapter (p. 95).

While South Africa has thus been remarkable for yielding stones of exceptionally large size, it must also be admitted that the quality of the gems brought to light is by no means unsatisfactory. True, a large number of the Diamonds are "off-coloured" stones, generally exhibiting a delicate straw-tint, but none the less they are extremely brilliant when properly cut. A very fair proportion of the South African Diamonds are of the first water, rivalling in beauty and purity the finest Brazilian and Indian Stones. This is especially the case with the Diamonds from the Jagersfontein and Koffyfontein mines in the Orange Free State. With regard to the Kimberley mines it is found that iron pyrites exists in large quantities, and the theory has been broached that to this cause is due the extraordinarily large number of coloured or "off-colour" stones, that are found there; while in the Jagersfontein mine iron pyrites is not found, and nearly all the Diamonds found there are the purest white. The great majority of these stones are not only pure in colour, but splendid crystals, symmetrical in shape and readily cu[illegible]

It has been estimated that about [illegible] of the Cape Diamonds are of the first [illegible]

of the second; and 20 per cent. of the third; the remainder being "bort." The average value of rough Diamonds at a sale on the Fields is as follows: "River," 65*s.*; "Jar," 45*s.*; "Du Toit's Pan," 28*s.*; "Kimberley and De Beers," 21*s.* to 22*s.* 6*d.*; "Bultfontein," 18*s.* 6*d.*, and "Wesselton," 25*s.*

It is said that Diamonds from the Leicester mine are mostly hard, white, cross-grained stones, with an etched or frosted appearance; whilst those from the Newlands' Mines, lately discovered in Griqualand West, are well-crystallized stones of remarkable whiteness.

All Diamonds which are too impure for cutting are now known under the general name of *bort*; and these possess a fixed market value, the powder which they yield when crushed, being used for cutting and polishing Diamonds and other stones, and in the engraving of gems of exceptional hardness.

Notwithstanding the enormous number of Diamonds which have been brought to light during the recent workings in South Africa, it is notable that, so far as the author knows, no *Carbonado*—the black, impure variety of Diamond found in Brazil—has yet been discovered though the ilmenite, or titaniferous iron-ore, sometimes passes improperly under the name of "carbon."

The following information is interesting as giving the latest results of working at the various Diamond Mines of South Africa:—

Produce of the DE BEERS MINE.—*Out-put of Blue or* [illegible] *amond-bearing* [illegible] —To end of June, 1897 [illegible] from this mine was [illegible] feet, which was mined

from the various levels as follows :—

740 and 770 foot levels	...	111,079 loads
800 foot level	...	121,238 „
840 „ „	...	145,045 „
880 „ „	...	175,225 „
920 „ „	...	246,184 „
960 „ „	...	315,380 „
1,000 „ „	...	238,227 „
1,040 „ „	...	70,378 „
1,080 „ „	...	45,410 „
1,120 „ „	...	1,924 „
Development Work ...	...	72,873 „
		1,542,963 „

The total cost of mining and depositing was 5*s.* 1·7*d.* per load of blue ground, as against 4*s.* 7·7*d.* for the previous year. The out-put is practically the same as for 1896, while the total expenditure is £36,000 greater.

Everything is being and will be done to bring about the same condition of things in De Beers as in Kimberley Mine. The problems are not the same, for in the Kimberley Mine the debris had fallen down as the blue ground was extracted, and had left the hard rock (melaphyre) exposed to view, and it could be seen where the streams of water flowed into the open mine; but in De Beers no hard rock has yet been exposed, and the miners have to grope in the dark, as it were, to find out where the water enters the open or worked-out portion of the mine.

The cost of washing was 2*s.* 1·8*d.*, as against 2*s.* 7·9*d.* per load for the previous year. The average cost of winning and washing the Diamonds was 7*s.* 3·5*d.*, as against 7*s.* 3·6*d.* per load for the year 1896.

In June, 1897, the 2 mines had on the floor, 3,082,599 loads of blue earth, valued at 1*s.* 6*d.* a load, and worth £231,194, 18*s.* 6*d.*

Produce of the KIMBERLEY MINE.—*Out-put of Blue Ground.*—To end of June, 1897. The total quantity of blue ground hoisted from the mine was 972,926 loads, which had been extracted from the various levels as follows:—

No.	14 or	1,005	foot level	...	13,423	loads.
"	15 "	1,045	"	...	96,104	"
"	16 "	1,085	"	...	104,026	"
"	17 "	1,120	"	...	153,403	"
"	18 "	1,160	"	...	154,583	"
"	19 "	1,200	"	...	220,492	"
"	20 "	1,240	"	...	103,633	"
"	21 "	1,280	"	...	55,308	"
"	22 "	1,320	"	...	44,682	"
"	23 "	1,360	"	...	12,587	"
"	24 "	1,400	"	...	6,363	"
"	25 "	1,440	"	...	1,711	"
"	26 "	1,480	"	...	1,628	"
"	27 "	1,520	"	...	4,983	"
					972,926	

At the Kimberley Mine the best day's work from the 1,200 foot level was 5,131 loads in 12 hours, and since winding has been going on from the 1520 foot level, the maximum out-put for 12 hours has been 4,675 loads.

THE WESSELTON MINE.—As soon as this mine's output became serious, having in June, 1897, produced 271,777 loads, valued at 1/-, =£13,588 17*s.* 0*d.*, the De Beers Company thought it best to buy it up so as to keep up the monopoly in their hands.

DU TOIT'S PAN AND BULTFONTEIN.—De Beers Company own these mines, also with others below, but have stopped working them, in fact, shut them up. In Bultfontein there are still a few claims owned and worked by a separate company, but the result is thought to be very poor.

JAGERSFONTEIN.—De Beers Company has acquired a preponderating interest in Jagersfontein, which is in the Orange Free State. It is being actively worked, and produces a fair quantity, enabling them to pay their shareholders a dividend last year of 12 per cent.

THE KOFFYFONTEIN—in the Orange State, produces very fine Diamonds, but in very small quantities, insufficient to make the company a success.

THE ROBINSON.—This is situated in the Orange River Free State. Very little is known of the capabilities of this mine, beyond that Diamonds have been found in it of very distinctive character, but none have yet been offered for sale in the market, though "Streeter's" have cut some of very fine quality for the parties connected with it.

LEICESTER MINE.—This mine produces a small output, but so far the company working it is far from a success; still, undoubtedly, there are possibilities of the mine becoming productive when further developed.

THE FRANK SMITH MINE and THE OTTO'S PROSPECT MINE—These Mines are situatedin Griqualand West, between the Vaal and Hartz Rivers, and about 40 miles from Kimberley. These mines produce very

fine Diamonds, but whether they can be worked at a profit has yet to be proved. Sufficient work has not yet been done on which to form an opinion.

Outside the group worked by the De Beers Company, the production of Diamonds from other mines is small, and not as yet, though we cannot say what will happen, sufficient to interfere with the practical monopoly exercised by the De Beers Company, or seriously to compete with them in the market.

"THE EXCELSIOR."

THE LARGEST KNOWN DIAMOND.
NATURAL SIZE IN ITS ROUGH STATE.
WEIGHT, 970 CARATS.

CHAPTER III.

AUSTRALIAN DIAMONDS.

ALTHOUGH three, at least, of our Australian Colonies have yielded Diamonds, it is only in New South Wales that they have been found in sufficient quantity to invite systematic exploration. As far back as the year 1851, Mr. E. H. Hargraves, in a Report dated from Guyong, referred to some specimens of gold, and to a number of gems, including what he called, rather vaguely, "a small one of the Diamond kind," found in Reedy Creek, near Bathurst. Mr. Stutchbury, the Government geologist, also reported in 1851, that he had seen a finely crystallized Diamond from the Turon River. But it was especially the late Rev. B. W. Clarke, a gentleman well-known for his researches in Australian geology, who first directed public attention to the Diamonds of New South Wales. Four specimens had been brought to him from the Mácquarie River, near Suttor's Bar, in September, 1859, and a fifth, the following month, from Burrendong. In the meantime he had received Diamonds from Pyramul and Calabash Creeks. These discoveries were considered by Mr. Clarke so significant, that he wrote a description of the occurrence, boldly heading it with the startling title, "New South Wales a Diamond country!" This announcement was not commercially justified till seven or eight years later, when the gold rush occurred at Warburton, better known as Two-mile flat, on the Cudgegong River, about nineteen miles

north-west of Mudgee. The Cudgegong empties itself into the Macquarie, which is an affluent of the Darling. As soon as the gold diggers had set to work they detected Diamonds; and in July, 1869, operations were conducted by the Australian Diamond Mines' Company of Melbourne.

At the Mudgee workings, gems were found in an old river-drift, believed to be of Pliocene age, distributed in local patches, which are remnants of deposits once widely spread over the district, but now partially removed by denudation. These ancient river-gravels occur at various distances from the actual channel, and at elevations of forty feet or more above the level of the river. They are generally covered by a protective layer of basalt, sometimes columnar; and shafts have been sunk through the basaltic cap, so as to reach the under-lying Diamond-drift, which rests either on vertical palæozoic strata or on massive greenstone. The older drifts have been in some cases re-distributed, thus forming gravels of the Pleistocene and later periods. The drifts contain pebbles and boulders of Quartz, Tin-Stone, Rock-Crystal, Jasper, Agate, and other siliceous minerals, mixed with coarse sand and clay, and in some places united by a siliceous cement, into a compact mass. Among the pebbles of the gravel, the diligent seeker may find many of the rarer minerals, including crystals of Topaz, Sapphire, Ruby, Zircon, Spinel, and Garnet; with Gold and Diamonds. The Diamonds are irregularly distributed through the gravels; but hardly in sufficient numbers to pay for the working, though some of the Diamonds from the Cudgegong Field are remarkable for their beauty and purity of colour.

Within the last few years a Diamond-field has been opened up near Bingara, New South Wales. This town is about 400 miles north of Sydney, on the river Horton,

popularly known as the "Big River." According to Professor Liversidge, of Sydney, the Diamond-bearing deposits are situated in a kind of basin, about four miles long and three miles wide, hemmed in by hills on all sides save on the north. The Diamonds occur in Tertiary and Pleistocene drifts, as in the Cudgegong Field. The old river-drift rests upon rocks of Devonian or Carboniferous age, and is partially covered by a capping of basalt. In some places the materials of the drift are compacted together into a conglomerate, so that the mode of occurrence of Diamonds at Bingara strikingly resembles that at Mudgee. The minerals composing the gravels are also generally similar in the two cases, though points of difference are not wanting. One of the best indications of the presence of the Diamond, according to the Bingara miners, is a black Tourmaline, known locally as "Jetstone." Some of the Diamonds are clear and colourless, others have a pale straw-tint: all are of small size, the largest yet known weighing about eight grains. According to an examination of some of the Bingara drift, by the Gwydir Mining Company, a ton of "stuff" yields on an average twenty Diamonds. Up to August 26th, 1873, the Eaglehawk claim had produced 1,680 Diamonds; but as the aggregate weighed only 803 grains troy, the very small size of the average stone is sufficiently apparent. The general weight of the Diamonds of New South Wales ranges from $\frac{1}{8}$ to $1\frac{1}{4}$ carat per stone, but, though small, they are extremely hard and brilliant. The Australian Diamond Company's claim is situated about six miles S.W. of Bingara.

Considerable interest has been recently aroused by the remarkable results obtained at the Monte Christo mine, in the Bingara Diamond Fields. This mine is situated on a hill, about 750 feet above the Gwydir River, which is four

miles distant. The drift has lost its basaltic capping, which has been removed by denudation, and the drift itself has probably been re-distributed. Captain Charles Rogers, the proprietor, estimated that the wash-dirt would yield about 30 carats of Diamond to the load of 27 cubic feet. Mr. G. A. Lawson, during a visit to the mine, obtained 122 Diamonds from one barrow-load of the drift, and 146 from a second barrow-load; as it takes ten barrows to form a "load," the richness of the deposit is very remarkable. The Rev. Milne Curran states that while he was visiting the mine, 29 small Diamonds were washed out of a hundred-weight of the drift. He calculated, from an examination of several parcels, that about 12 per cent. of the Diamonds are really good stones, 45 per cent. are marketable, and 20 per cent. more may be worth cutting, whilst the remaining 23 per cent. are useless as gems.

Of late years considerable attention has been given to the Diamond-bearing drifts in the tin-mining districts near Inverell, not far from the junction of Cope's Creek with the Gwydir River. The field known as Boggy Camp is situated about 12 miles south-west of Inverell, in the parish of Mayo, County of Hardinge. The tin-drifts, which consist of deposits of sand and gravel, placed between floors of basalt above and a granitic bed-rock below, contain not only Diamonds, Gold and Tin-stone, but such minerals as Sapphire, Zircon, Tourmaline, Garnet and Topaz. The famous claim known as "The Star of the South," is situated on a hill of basalt, in which shafts have been sunk to the underlying drift, and levels have been systematically driven to open up the wash-dirt. In the course of eighteen months upwards of 3,000 Diamonds were found. Mr. E. F. Pittman, the Government Geologist of New South Wales, stated in his official Report for 1895, that when he

visited the field 42 loads of drift had yielded 600 carats of Diamonds. One load of wash-dirt, of exceptional richness, yielded no fewer than 515 Diamonds, of the aggregate weight of 184 carats. The Diamonds are described as similar in size and quality to those found on the Bingara Field.

In 1897 a London Company was formed for the purpose of working these and other deposits of Diamonds in New South Wales, under the name of "the Inverell Diamond Fields, Limited," with Mr. C. Barrington Brown, as consulting engineer. The Diamonds hitherto obtained have been only of small size, but they are extremely hard, and when cut exhibit exceptional brilliancy.

At the Mining Exhibition held at the Crystal Palace in 1890, Professor Liversidge, of Sydney, exhibited some interesting Diamonds from New South Wales, including a crystal from the Lachlan River, and a black Diamond from Mudgee.

Compared with the Diamond discoveries in New South Wales, those of other parts of Australia sink into insignificance. South Australia is rich in mineral treasure; but this treasure mostly takes the form of ores of copper and iron; yet the colony is not without its gold-fields, and with the gold a few Diamonds have been found. In the year 1852, Diamonds were discovered in alluvial gold washings in the hills near Echunga, rather less than twenty miles south-east of Adelaide. It is said that more than a hundred Diamonds have at different times been found in this neighbourhood. Sir Arthur Blyth, then Agent-General for South Australia, exhibited about twenty Diamonds from Echunga at the Paris exhibition of 1878. One octahedral crystal weighed $5\frac{5}{16}$ carats, and another $3\frac{1}{4}$ carats. Mr. Dodd who reported on them, called attention to their

similarity in many respects to Brazilian Diamonds, and pointed out that they were found to be much harder than the Diamonds of South Africa.

Whilst Victoria is pre-eminently the "Golden Colony," it is only now and then that a solitary Diamond has been found there. In 1862, the discovery of a Diamond in the Ovens district was announced by Mr. George Foord. It was a transparent yellow crystal, with perfect edges, weighing about two grains. The Rev. J. J. Bleasdale, who paid great attention to the study of Australian gems, described three Victorian Diamonds—two from Beechcroft, and the third from Collingwood Flat. There appears, however, to have been some little doubt hanging over the reputed discoveries of Diamonds in Victoria; but in 1865 an Exhibition of Gems was held in the Hall of the Royal Society of Victoria, and from the specimens then exhibited and the information accompanying them, the matter was set at rest. "The results of this exhibition," said Dr. Bleasdale, "have now placed this important truth beyond impeachment." Altogether about sixty Diamonds have been found in the Beechworth district, but they have not been of good colour, nor of large size, most of them weighing less than a carat.

The first Australian Diamond ever brought to this country was presented by Sir Thomas Mitchell to the Museum of Practical Geology, in Jermyn Street, where it may now be seen. This small crystal weighs $\frac{3}{4}$ of a carat, and was found near Ophir, west of Bathurst, New South Wales.

CHAPTER IV.

BORNEO DIAMONDS.

THERE can be no doubt that Diamonds are very widely distributed in the island of Borneo. Dr. Theodor Posewitz, a mining engineer, who resided there for nearly three years, published in Berlin, in 1889, a valuable work, in which he discusses at great length the mineral resources of Borneo, and gives an interesting description of the occurrence and production of Diamonds. Much has also been written on the subject in the reports of the Mining Department of the Dutch East Indies.

Extensive Diamond-fields exist in the rich gold-bearing district of Tanahlaut, especially near Martapura, in the south-east of Borneo. Kusan, in the east of the island, is also a district of much repute for both Diamonds and gold. But, perhaps, the most famous locality is Landak, in Western Borneo. Landak is situated a few miles E.N.E. of Pontianak, the capital of Dutch Borneo, and is about three day's steam from Singapore. Sangan, also in the west, likewise yields Diamonds, especially in the rivers Sikajam and Meran. Finally, the Sarawak River has, of late years been cited as a Diamond-yielding stream, and some very fine Diamonds, both white and of rare fancy colours, have been found there; but the deposits can be worked for only a few months in the year.

At all these localities the Diamonds are found with gold and, in some cases, with platinum, in the sands of the rivers; and also in beds of clay, sand and gravel, sometimes at a considerable depth. A blue or bluish-grey Corundum, known as *Batu timahan*, is said to be a constant companion of the Diamond, the natives regarding it as an attendant on the "Prince," as they term the more precious stone. Dr. Verbeek thinks that the original matrix of the Diamond, which yielded the stones occurring in the drifts, is to be found among the older slaty and schistose rocks; whilst the late Prof. Carvill Lewis suggested that the Diamonds had been brought up from depths by the serpentine, or altered peridotite, which appears to be not uncommon in the Diamond districts of Borneo.

The natives wash the sands of the rivers in small bowls, and become so expert in detecting the valuable stones that they can separate the Diamonds from the worthless minerals, even when so small as to escape observation by Europeans. The drifts are worked by means of small shafts sunk through the overlying deposits, and the Diamond-yielding bed is then followed by little tunnels driven in a very primitive manner. Considerable improvements have, however, been introduced by the Chinese, who are extremely skilful and economical miners. Of late years Europeans have entered the field, and Diamond-mines in Tjempaka are now worked by French engineers; but the washing of the Diamond-earth after its extraction is said to be still done on the old Malay system.

The Diamonds of Borneo usually occur in crystals, presenting the form of the octahedron, the cube and the rhombic dodecahedron. If they present bright faces and sharp angles, and are considered by the natives to need no

polishing, they are called *intan mendjadi.* The uncut Diamonds are called *podi;* the cut stones *intan.*

According to Posewitz the following varieties are distinguished :—

Intan Katja hitam, of bottle-green colour, and of great value.

Buntat intan, hard, dark and not to be cut: when spherical, they are called the "Soul of the Diamond," and are worn as amulets.

Intan-ajer-Laut, or Sea Water Diamonds, of pale blue colour.

Radja intan, or King of Diamonds; of red colour, very rare.

Intan minjak, brown Diamonds.

Chaping, triangular flat twin crystals.

The largest Borneo Diamond discovered of late years was found in 1865 at the diggings of M. Beretti at Tjempaka. It weighed in the rough 25 carats, and when cut 18½ carats.

A Diamond of 77 carats was found near Gunong Lawak, in South Borneo, and passed into the possession of the Sultan of Martapura. It is said that a Diamond weighing 70 carats, known as "Segima," is the property of the Sultan of Matan.

The art of cutting and polishing Diamonds has long been parctised by the natives of Borneo, and is rather extensively carried on at Pontianak and Martapura. In the case of octahedral crystals, they simply rub down the solid angles at the top and bottom, and having polished these culets regarded the work as complete, never allowing the stone to lose weight by cutting facets on the sides

Of late years the Diamond-industry of Borneo has suffered a serious decline. This is due partly to the fact that the superficial deposits have been mostly worked out, and the working of the drifts below is expensive and troublesome: the rulers, too, do but little to encourage Diamond working, as they claim all the large stones for themselves, and exact a royalty on the small ones. But the chief cause of the depression is, no doubt, traceable to the influx of Diamonds from South Africa, and consequent depreciation in the value of the Borneo stones. If, however the deeper Diamond-drifts, which have as yet been scarcely touched, were systematically worked on a large scale by Europeans, with scientific appliances, there seems reason to believe that the Diamond industry of Borneo might be successfully and profitably revived. It is very notable that Borneo has produced more "fancy stones," or beautifully coloured Diamonds of the rarer tint, such as red, green, and blue, than any other known country, and what is still more curious a smaller number of pale yellow and off-coloured stones.

CHAPTER V.

BRAZILIAN DIAMONDS.

IN washing the sands of some of the Brazilian rivers, for sake of the gold which they contained, the natives in the early part of the last century occasionally lighted upon little hard stones of pecular shape, which they regarded as of no value; and therefore either threw them away, or used them as counters in card-playing. It was not until 1727, that Bernardo da Fonseca Lobo, an inhabitant of Serra do Frio in the gold district of Minas-Geräes, accidentally discovered the true nature of these stones. He had seen rough Diamonds in India, and the likeness to these was so striking that he took a number to Portugal for sale, and thus drew general observation towards the new Diamond mines. Such at least is the story told of the discovery of the Brazilian Diamond fields.

The European merchants, who up to that time had obtained their Diamonds from India, were frightened lest this discovery should cause a fall in the price of the gems in their possession. They consequently spread the report that the Brazilian Diamonds were only the refuse of the Indian stones, forwarded to Goa, and then to Brazil, just as when the South African Diamond fields were discovered, it was said that they yielded only yellow stones, of little or no value.

The Portuguese, however, turned the tables, and sent the Brazilian Diamonds to Goa, and thence to Bengal where they were offered for sale as Indian stones, and obtained Indian prices.

It is only within the last few years that the Diamond-bearing rocks of Brazil have been sufficiently studied to enable geologists to speak with anything like confidence, in regard to their nature and their age. They have now, however, been thoroughly examined, especially by Prof. Gorceix, the head of the School of Mines at Ouro Preto, the capital of Minas-Geräes, and by Prof. Orville A. Derby, of the Geological Survey of São Paolo. Sections have been made of the strata, of which the Diamond-bearing provinces are composed, and a satisfactory sequence has been established.

The mode of occurrence of Diamonds at Diamantina, (formerly called Tejuco), in the province of Minas-Geräes may fairly be taken as typical of the workings throughout the country. It was here that Diamonds were originally discovered in Brazil, and it was to this district that the workings were for a long time restricted. Diamantina itself is situated along the crest, and on both flanks of the great interior mountain range of Brazil, which, at a general height of about 4,000 feet above the level of the sea, divides the waters of the São Francisco on the west, from those of the Doce Jequetinhonha and other rivers on the east. The northward prolongation of the range includes the Diamond regions of Grão Mogol, in the province of Minas-Geräes, and that of the so-called Chapada Diamantina in Bahia.

A very important group of rocks stretches from the former to the latter of these rivers. This group has been called the Itacolumite series, from the occurrence of

Itacolumite, a rock which was named by Eschwege, from the Serra do Itacolumi. The true Itacolumite of petrologists is a sandstone, remarkable for possessing flexibility, so that a thin slab admits of being readily bent to and fro. This pecular rock is, however, only a rare variety of the Itacolumite, most of which is a granular schistose quartzite, or metamorphic sandstone, destitute of flexibility.

The Brazilian Itacolumite long figured in works on mineralogy as the original matrix—the true parent-rock—of the Diamond; and the occurrence of a somewhat similar rock with Diamonds in India and in North Carolina led to premature generalizations as to the origin of the gem.

In the geological section under description, the Itacolumites are associated with a group of hydro-mica schists and Itaberites, or schists containing specular iron-ore. Traversing these rocks are certain more or less defined veins of clayey matter containing Diamonds. The mineral is here supposed to occur in its primitive position, the clayey material being probably its decaying matrix. Diamonds are also found in the quartzites of an overlying series, but here they are to be regarded as pebbles washed out of their original home in the lower group of rocks. They are likewise distributed through the gravels of the Brazilian Highlands, where they find a resting-place after having been set free from their enclosing matrix. It is possible then that a Diamond, born originally in the lower metamorphic series, may have been transported among the materials which enter into the constitution of the upper series, and then on the wearing down of these upper rocks, may have been once more disturbed, and finally deposited in the gravels of the present river valleys. Such appears to be the geological history of many a Brazilian Diamond.

The Diamond washings in the neighbourhood of Diamantina are performed either in old river gravels or in the beds of rivers, in whose bottoms continuous pot-holes or cañons are found, filled with the Diamond-bearing gravel. The courses of the rivers are turned by means of temporary dams or wooden sluices, and the Diamond-bearing gravel hollowed out. The principal minerals associated with the Diamond are anatase, rutile, brookite, specular iron, martite, topaz, tourmaline, and native gold.

At São João da Chapada, about 12 miles to the west of Diamantina, the Diamond occurs embedded in clay, or *barro*, under the conditions which have been described by Prof. O. A. Derby. The clay contains grains of quartz and microscopic tourmalines, but the rock from which it has been derived by decomposition has not been definitely detected.

About 100 miles north of Diamantina, on the Corrego dos Bois, near Grão Mogol, the Diamond has been found in a solid conglomerate rock named by the miners "Pigeons' Eggs." This was formerly regarded as the Itacolumite, but has been identified with the upper series, overlying the true Itacolumite group. In 1839 about 2,000 people flocked here to work.

Diamonds occur in the valley of the River Tibagy (in the Province of Paraná, in Southern Brazil) and in its tributaries the Yapo and Pitangru. The stones are found not only in the sands of the river, especially in pot-holes, but in old beds of gravel at some distance above the present level of the river, where "dry washings" have been established. The story told of the discovery of Diamonds here is, that a labourer, living close to Tibagy, produced a tiny bamboo stem, the open end of which was stuffed with a twisted leaf of milho; on extracting this, some small,

but good Diamonds were found in the hollow stem. On pursuing this investigation further, most of the workmen's huts in the immediate neighbourhood were found to have some such stones hidden within them; but the gems were as a rule, small, hardly ever exceeding one carat in weight.

According to Prof. O. A. Derby, who examined the Tibagy Diamond-workings geologically, the gems appear to be derived from the Devonian sandstone, through which the river flows; but the materials of the sandstone are themselves derived from the metamorphic rocks. Gold is widely distributed through the Tibagy district, and the Diamonds, though usually small, are of good colour and great brilliancy. The author, some years ago, joined a syndicate to work the sands in the bed of the Tibagy, but though both Gold and Diamonds were found they did not occur in sufficient quantities to render the working remunerative, and the Tibagy Diamond-fields were consequently abandoned.

The most important districts of the deposits of Diamond-bearing gravel in Brazil lie between 12 degs. and 26 degs. south latitude, including the provinces of Minas-Geräes, Bahia, Goyaz, Mato Grosso, Parana and S. Paulo.

The supply of Diamonds was greatly increased in the early part of this century, by the discovery of new and richer mines in the province of Bahia, the stones of which are called in commerce *Bahias*. The yield from these mines, although considerable in quantity, is, however defective in size, and inferior in average quality. The proportion of pure stones is less, and of the "off-coloured" varieties greater, than in the produce of other mines; nevertheless, the exceptionally fine stones are as beautiful as any hitherto discovered elsewhere.

With the Diamonds of Bahia is found an impure black, grey, or brown crystalline carbon, known in commerce as *Carbonado*, and highly valued for mounting in the steel drill-heads used for Diamond-boring—a purpose for which neither crystalline Diamond nor bort is applicable. This will be referred to at length in a subsequent chapter.

In 1772 the Government of Brazil first worked the Diamond mines on its own account. Rich as the fields were, the cost was enormous, and every carat weight of Diamonds cost the Government from fifteen to eighteen shillings, against six shillings and sevenpence in South Africa.

The profit made in Minas-Geräes was formerly very considerable. In the first twenty years 144,000 carats of Diamonds were found annually. Up to 1850 this Province had yielded about 5,844,000 carats of Diamonds valued at £9,000,000. If, in addition to this, we consider the contraband trade at the beginning of this century, estimated at £2,000,000, the worth of the Diamonds found in Minas-Geräes would be about £11,000,000. The Diamonds from these mines differ from those of the Bahia mines in shape and colour. The form of the stones is more regular, while the colour is more uniform in its greenish tints, and less, if at all, vitiated by any yellow reflection.

The Paraguay and its many tributaries carry down gold and Diamonds. During the dry season, from April to the middle of October, when the depth of the river is much diminished, the water is drawn off into a canal, and the mud of the river bed is dug out to a depth of six to ten feet, and carried to a place where it can be washed by the negroes during the wet season. In digging out the mud, large holes are often found containing many Diamonds and much gold. When the wet season stops the digging, the scene of action is the "washing huts."

Washing troughs (canoes) are placed side by side, and the overseer has a raised seat, so as to be able to observe all the negroes at work. Every trough has its little stream of water, and a negro keeps the contents in constant motion until the mud has been washed away and the water is quite clear. Then the sand and fine gravel are taken in the hand and searched for Diamonds. If one is found, the negro stands upright and knocks as a signal for the overseer, who takes the Diamond from him, and lays it in a vessel filled with water, which hangs in the middle of the shed. When the day's work is over, the contents of this vessel are taken by the overseer, and their weight entered in a book.

Large Diamonds are very rarely found. It has been estimated that in *ten thousand* specimens rarely more than *one* weighing *twenty* carats is met with, while possibly eight thousand of one carat, or less, may be discovered. At the works of the Jequetinhonha River, during a year's labour, only two or three stones have been found varying from seventeen to twenty carats, and at the whole of the works in Brazil, for the space of two years, not more than one of thirty carats was found. In 1851 a Diamond weighing 120⅝ carats was discovered at the source of the Patrocinho River, in the province of Minas-Geräes.

Somewhat later, on the Rio-das-Velhas, the labourers found a stone of 107 carats weight, and in Chapada one of 87½ carats. The largest, however, which has been discovered in Brazil is that called the "Star of the South," which was found in 1853, at Bogagem, in the Province of Minas-Geräes, and weighed 254½ carats before it was cut.

There are many laws and regulations in Brazil to prevent the negroes concealing and smuggling Diamonds. As a means of encouraging honesty, if a negro finds a large

stone he is crowned with a wreath of flowers, led in procession to the manager, and formerly his freedom was bestowed upon him. If a negro finds a Diamond from eight to ten carats weight, he receives two new shirts, a suit of clothes, a hat, and a handsome knife. This, at least, was formerly the case.

For unfaithfulness the negroes are beaten with sticks, or have iron bands fastened round their throats; and on repetition of the fault they are not admitted to the works again. Notwithstanding all these rewards and punishments, one-third of the produce is supposed to be surreptitiously disposed of by the labourers. Manifold are the tricks used by the negroes to appropriate and barter the gems they discover. In the very presence of the overseers they manage to conceal them in their hair, their mouths, their ears, or between their fingers; it has been said that not unfrequently they will throw them away, and return for them at the dead of night.

The discovery of these Precious Stones in 1746 proved a great curse to the poor inhabitants on the banks of the Diamond rivers. Scarcely had the news of the discovery reached the Government ere they tried to secure the riches of these rivers for the Crown. To effect this the inhabitants were driven away from their homes to wild, far-away places, and deprived of their possessions, while a dreadful drought, succeeded by a violent earthquake, increased their distress. The Diamonds were found in great numbers, and under curious circumstances. After a heavy shower the children would find Diamonds in the streets, and in the brooks which traversed them, and would often take home three or four carats of Diamonds. One negro found a Diamond at the root of a vegetable in his garden. Poultry, in picking up their food, swallowed Diamonds, so that their viscera required searching before being disposed of.

When Diamonds were first discovered in Bahia, the old capital of Brazil, which was at the time a densely-populated and fruitful province, the observant and intelligent Portuguese minister, the Marquis de Pombal, forbade further search, as he feared that agriculture, which he justly regarded as a source of blessing and health to the land, would suffer.

A very strange history is connected with the discovery of Diamonds in Bahia. An intelligent slave from Minas-Geräes, keeping his master's flocks in that province, thought he observed a similarity between the soil of his native place and that of Bahia. He sought therefore in the sand, and soon found 700 carats of Diamonds. Fleeing from his master he carried these with him, and offered them for sale in a distant city. Such wealth in the hands of a slave caused him to be arrested, but he would not betray himself. The master to whom he was given up tried to get at his secret by cunning, but without avail, until he thought of restoring to him his former occupation in Bahia, and watching him. As soon as the secret was known numbers flocked from Minas-Geräes and other parts of Brazil to Bahia, so that the following year as many as 25,000 people were occupied in seeking Diamonds there, and the amount daily secured for some time rose to about 1,400 or 1,500 carats.

The number of Diamond-seekers however, gradually dwindled to between five and six thousand; but up to the end of the year 1849 there had been as many as 932,400 carats of Diamonds obtained from the Chapada of Bahia. This field is about eighty miles long and forty miles broad.

The total produce from the entire Brazil Diamond districts was calculated up to the year 1850 to exceed 10,000,000 carats. In the year 1851 the produce appeared

to be increasing; but in 1852 it was evidently on the wane. The estimated value of Brazilian Diamonds from 1861 to 1867, the date of the discovery of the South African Diamonds, was about £1,888,000.

Some very interesting information was given by the German traveller, Herr von Tschudi, who visited the city of Diamantina, in February, 1858. He observes: "The pivot on which Diamantina turns is Diamonds. I was present during the unexampled commercial crisis which extended from town to town, and country to country, with such disastrous consequences, and which fell with the weight of an avalanche on the inhabitants of Diamantina. All business was stopped, and Diamonds fell to one-half the price they reached only the year before."

The panic described by Von Tschudi was severe, but it is very doubtful whether any panic was ever equal in extent and importance to that caused by the discovery of the riches in South Africa, which produced a revolution in the Diamond market.

No country was more incredulous about the prodigious yields of the South African mines than Brazil, and this perversity made the loss disastrous to the Brazilian merchants, as they refused to receive the warnings which were sent them in perfect good faith. The favour bestowed on the Cape Diamonds, and the great margin of profit which they yielded, resulted in the Brazilian Diamonds being more and more neglected; and as the difficulties were augmented by the predilection of Amsterdam workmen for the new stones, a depreciation followed greater than that which the prices obtained for Cape stones justified.

The Cape yield of large stones led to the general rejection of the small, such as were furnished by the Brazil merchants in every parcel which they supplied to the

market. The alternative of sending only finer specimens to the practical exclusion of small stones, if they intended seriously to enter into competition with Cape gems, was a matter of anxious concern to them, not because the Brazilian Diamonds had deteriorated in beauty or in quality, but because the exorbitant prices at which they had been offered for sale could no longer be maintained. It is a well known fact that, owing to the increasing scarcity of stones, the working of the Brazilian mines gradually became barely remunerative; and at the present time it hardly pays to work for Diamonds in Brazil.

CHAPTER VI.

BRITISH GUIANA DIAMONDS.

IT is known that Diamonds occur in British Guiana, but little has hitherto been done in systematically searching for them. From time to time, those who are engaged in washing gold, in the placer diggings, find crystals of Diamond; and some of these have been described as well-formed octahedral crystals, of excellent colour and quality. The gravels of the Mazaruni River are noted specially as being diamantiferous. In 1891, some prospecting parties from Georgetown proceeded up this river, and obtained a number of small Diamonds, but this success does not seem to have been followed up. The present state of our knowledge does not justify us in predicting anything as to the probable future of British Guiana as a Diamond-producing colony.

CHAPTER VII.

INDIAN DIAMONDS.

ALTHOUGH the Diamond fields of India have been celebrated from remote antiquity, it is only of late years, that our knowledge of Indian geology has been sufficiently advanced to enable the mineralogist to speak with even approximate accuracy as to the nature of the Diamond-bearing rocks of that country. The materials accumulated by the Geological Survey have been rendered accessible to the public, by the issue of an admirable "Manual," of which the third volume is devoted to Economic Geology—a subject which the late Prof. V. Ball, treated with great ability. A fourth volume, by Mr. F. R. Mallet, forms a kind of supplement to this work. The geological conditions under which the Diamond occurs in India are fully dealt with in this official Manual.

The Diamonds of India are generally found in superficial deposits derived from the disintegration of the solid rocks. Where the Diamond apparently occurs *in situ*, it is in certain rocks belonging to the great *Vindhyan formation*, a formation which derives its name from the Vindhyan hills of the old geographers, and which is of very great but unknown geological antiquity. At the Panna mines, Diamonds have been found embedded in a conglomerate belonging to a minor division of the Upper

Vindhyans, known as the *Rewar group*; but this conglomerate is apparently formed of materials derived from the older or lower Vindhyan series. In Southern India the Lower Vindhyans are represented by the *Karnul group* and at the very base of this formation the Diamond is found. Such is its position, for example, at the Banaganpilly mines. But here again the Diamond rock is a conglomerate—that is to say, a detrital rock made up of pebbles derived from some yet older rock. Associated with these pebbles are the Diamonds; but whence the Diamonds came, from what rock they may have been broken, or out of what matrix they may have been washed, no one can say. Old workings for Diamonds have been discovered in the *Dharwar Conglomerate*, of still higher antiquity than the Banaganpilly, but whether these workings yielded Diamonds, or not, is unknown. If Diamonds were worked in this conglomerate their origin is thrown back to an excessively remote period of geological time.

In 1882, M. Chaper, a French mining engineer, engaged in exploration for Diamonds in Madras, announced that he had discovered the Diamond in its veritable matrix near Wajra Karur, not far from Bellary. According to his reports, submitted to the French Academy of Sciences, and to the Geological Society of Paris, the rock which he regarded as the parent of the Diamond, was a rose-coloured Pegmatite, but it has been shewn that his conclusions were based on erroneous observations.

Attention was called some years ago to the occurrence near Wajra Karur of a certain rock, closely resembling the famous "blue earth" of the South African Diamond fields. This "blue" forms a "neck" in a granitoid rock, containing epidote, and associated with hornblende gneiss; and it was assumed that it represented an old and altered volcanic

material, which had brought up the Indian Diamonds in a similar manner to that in which the Cape Diamonds have been carried up the volcanic ducts of Kimberley. Workings at this locality were, however, unsuccessful and resulted in a considerable loss.

There are three extensive districts in India which have yielded Diamonds on a large scale. Of these the most famous is the southernmost improperly termed the Golconda region, the old fort of Golconda, in Hyderabad, being far distant. It includes various mines on the Kistna and Godaviri rivers, and other localities in the Madras Presidency, which will be noticed in detail in the following pages. The second great tract lies in the Central Provinces, and includes the mines of Sumbulpur. The third is in Bundelkhund, where are situated the Panna mines.

In addition to these principal areas, a few other localities have yielded Diamonds. They have been found, for example, in Bonai; in the province of Chutia Nagpur; and, it is said, near Simla.

An account of the Precious Stones of India was given in a work entitled *Mani Málá*, by Rajah Sourindro Mohun Tagore, published at Calcutta, in 1879. Although some of the descriptions given are hardly scientific, yet the book contains much that is interesting with respect not only to the history of Precious Stones, but also as to their localities. The following list gives the names of the Indian localities in which the Diamond is said to occur, with the supposed modern equivalents of those names:—

1. Haima (Himalayas).
2. Mátanga (Kistna and Godaviri or Golconda).
3. Saurástra (Surat).
4. Paunda (probably included the Chutia Nagpur localities).

5. Kalinga (countries between Orissa and the Godaviri).
6. Kosala (the modern Ajodhya or Berar).
7. Vena Gangá (the Wemganga).
8. Saubira (the tract between the Sarhund and Indus rivers).

The most southern group of the Diamond strata begins at the environs of Cuddapah, or Kadapah, on the Pennar. Here for many hundred years Diamonds have been met with in small quantities. They are found in many places contiguous to each other: at Chennur or Chinon; at Cunnapurtee, opposite Chennur, probably the same locality as that described by Heyne and Newbold as Condapetta; at Woblapally or Obalumpally, at Vanniapenta, Ghunputty, Pinchetgapadu, Jummulmudgoo and Connucaseloo; all being villages not far from the river Pennar.

Near Cuddapah (475 feet above the sea) the Diamond conglomerate is superficial, and from 10 to 20 feet thick. The mountain rises 1,000 feet higher than this stratum, and its foot is everywhere covered with loose pebbles. The beds follow each other in the following order: uppermost a foot and a half of sand, grit, and loam; then a tough blue or black muddy earth, without any stones, four feet thick; under this comes the Diamond bed, characterized by the numerous large round stones embedded in it. It is from two to two-and-a-half feet thick and consists of pebbles and grit, bound together by loam.

At Cuddapah large blocks of hornblendic rock, mostly derived from the neighbouring mountain chain, constitute the chief mass of the Diamond bed.

The Obalumpally mines, also on the right bank of the

Pennar, are only a few hours' journey west of Cuddapah. The Diamond bed here seems to follow the course of the river, and is of varying width. Here the Diamonds always occur in more rounded crystals. Those found still further west are the best.

The villagers around the old Vanniapenta workings state that at a distant period, which they vaguely describe about a hundred years ago, some "great people" came to the place and dug into a fissure in the blue limestone, whence they extracted a large quantity of Diamonds. Other pits were then dug in the neighbourhood, but none of them proved productive.

In the Brahat Sanhita, which dates from about the Sixth Century of the Christian era, it is said that Diamonds were divided into four classes, according to their castes. 1st, *Brahmans*, clear and of "pure water," white as the flower of the lotus, or as crystal, 2nd, *Kshatriyas*, clear and of the colour of honey, or red like the eye of the hare. 3rd, *Vaysias*, cream-coloured or green like the fresh plantain leaf. 4th, *Sudras*, greyish-white, or like polished steel. The Sudra is said to be worth one-fourth, the Vaysia one-half, and the Kshatriya three-fourths of the value of the Brahman Diamond. The Sudras are the Diamond seekers who carry on their work without inspection, and pride themselves on their honesty. The pits which they dig are square excavations, not more than sixteen feet deep.

Among the Diamond-bearing localities in the district round Bellary may be mentioned Wajra Karur, Gunjee-goonta, and Guti or Gutidrug.

The native village of Wajra Karur ("Diamond Town") is situated about nine miles from Goondacal, on the Madras Railway, in the Gooty Taluk. The Diamonds are found

in the detritus covering the low county, and probably derived from the sandstones and breccias overlying the gneiss of the neighbouring hills. Diamonds have been found in the district from time immemorial, and Tippoo Sultan, when in power claimed all large stones, whilst he levied a royalty upon small ones. At the present time, the villagers turn out after heavy rains, and search for Diamonds.

In 1881 a Diamond of very fine quality, though of irregular shape, weighing in the rough $67\frac{3}{8}$ carats, was found near Wajra Kurar, probably a little to the north-west of the village. This stone was purchased by Messrs. P. Orr and Sons, of Madras, and yielded a fine brilliant called the "Gor-do-Norr," Mr. Gordon Orr being the senior partner, whilst the name, spelt thus, chimed well with "Koh-i-nur."

It is said that the "Eugénie" Diamond was found by a poor peasant at Wajra Karur. He offered the stone to the village blacksmith, in return for repairing his plough, but the smith thought so little of its value that he flung the stone away. Afterwards, however, he picked it out of a heap of rubbish, to which he had consigned it, and sold it for 6,000 rupees to Mr. Arathoon, a merchant in Madras, by whom it was disposed of, for a large sum, to the Emperor Napoleon III.

In the *Philosophical Transactions* for 1677, there is an interesting paper presented by the Earl Marshal of England to the Royal Society, in which it is stated that at the commencement of the seventeenth century a Portuguese gentleman went to Currure (Wajra Karur), and after much cost and labour obtained a large Diamond believed to have weighed about 434 carats, which he sold at Goa. The late Prof. Ball suggested that this stone may

have been the Pitt Diamond, though the discovery goes back nearly a century before the famous Diamond figures in history, and is contrary to the general belief, which refers the discovery of the Pitt to the mines at Parteal. In like manner, Ball suggested that the great Mogul's Diamond may have come from Wajra Karur, and this I think likely, notwithstanding Tavernier's statement that it was found at Kollur.

At the north end of the table-land, extending on the west side of the Nalla-Malla hills, as far as the town of Randial (672 feet above the level of the sea), lies another group of mines. The Diamond beds here are only about a foot thick, and both the over and underlying beds are more pebbly than in the first group.

Most of the Diamonds of this district lie loose in the *débris*. There is an erroneous impression among the poor miners that the Diamonds grow in and about the huge fragments of the crust of the earth which has been heaved and broken up. Among the natives of the Madras Presidency, there exists a curious belief that the rock-crystal, which occurs in the diamantiferous ground, will become Diamond when impregnated with electricity by the action of lightning. Voysey found about these mines at least a dozen parties each consisting of seven or eight men, working in their own lot or particular heap. He describes them as mostly of the lowest class—poor, miserable creatures, with little government, and with no superintendent to direct or regulate their labour. In the rainy season the miners work in the Diamond pits on the heights, and when the floods are over, in the low-lying mines by Kistna. Most of the Indian Diamond miners belong to the aboriginal tribes, their trade being hereditary. The Panna mines were worked formerly by Gonds or Kols,

and though some of the miners of Southern India are said to be Hindus, and others are simply described as low outcasts, yet they all probably are descended from the same Dravidian family.

The Diamond district of Banaganpilly lies five hours' journey west of Randial, surrounded by lofty plateaus, or flat-topped mountains, whose sides admit of cultivation. Heyne alleges that the mines are in the mountains, varying from one to two hundred feet in height, and that the Diamonds are found at a depth of about twenty feet from the surface. Voysey, who lived later than Heyne, asserts, in rectification of this statement, that, for many years past, it is only in the broken-up crust that the Diamonds are found.

Dr. King, the late Director of the Geological Survey of India, visited these mines, and described the Diamond-layer as a clayey conglomerate containing pebbles and fragments of shale, chert, and quartzite. This "gangue is pounded up, mashed, sifted, and laid out to dry on prepared floors, after which the residue of clean sand is carefully examined in the hand by the women and children of the working parties, for the precious gems." These gems, however, are evidently very rare, for Dr. King could not hear of a single stone being found during his stay of four or five days at the mines. Many other Diamond-bearing localities are known in the neighbourhood of Karnui, but in most cases the workings are now deserted.

In the valley of the Kistna, or Krishna, there are numerous spots in which Diamonds have been worked, especially at Kollur, which was probably the Gani Coulour of Tavernier: and at Parteal, or Gani Parteal. In fact, the localities in the Kistna and Godaviri valleys constitute the famous *Golconda district*, and are still being worked, though

at a loss. According to general belief, the Golconda district yielded the great historic Diamonds of India. It must be distinctly understood, however, that no Diamonds have ever been found at Golconda itself. Golconda, the former capital of the district, was simply the commercial centre, where the Diamonds were bought and sold, and at the present day the only representative of the world-famed Golconda, is a deserted fort near Hyderabad.

When Tavernier visited the district in 1669, there were as many as twenty mines at work, but now only two or three are worked by a company. Even the names by which Tavernier knew the mines have become obsolete, and not without difficulty can their situations be identified. The late Prof. Ball in his edition of Tavernier's *Travels*, published in 1889, entered with much erudition, into a discussion of this subject. The most famous of these, named "Gani" by the natives, but "Colore" by the Persians, gave employment in Tavernier's time, to 60,000 workmen. Ball brought forward strong evidence to show that Tavernier's "Gani Coulour" is identical with the modern town of "Kollur" on the Kistna—the word *Gani* being equivalent to the Persian *Kan-i*, or "mine of;" so that "Gani Coulour" meant simply the "Mine of Coulour," just as "Gani Parteal" is the "Mine of Parteal." Ball also sought to identify Tavernier's famous locality of Raolconda, where the old traveller saw Diamond-cutting carried on in the mine itself, with the town now known as Ramulkota, about twenty miles south of Karnul, where the Diamond occurs in a matrix of pebble-conglomerate belonging to the Karnul series.

The Diamonds found at Gani Coulour were distinguished for their number and size; but, except in rare instances, they were deficient in purity and clearness.

The largest and most celebrated found in this mine was said to be the "Great Mogul." In its rough state it weighed, according to Tavernier, $787\frac{1}{2}$ carats, but was reduced by Hortensio Borgio, in cutting to $279\frac{9}{16}$ carats.

Tavernier also gives an account of the Diamond-mining operations at Coulour, and relates how a mine was discovered by a countryman, who, digging to sow some millet, found a pointed stone weighing about twenty-five carats. Not knowing what it was, he took it to Golconda, where he showed it to a trader in Diamonds, who recognizing its value, enquired as to the locality where it was found. The report of a Diamond mine made a great sensation in the country, and the influential men of the town caused the ground to be worked. They were well rewarded for their trouble by the discovery of large stones, averaging from ten to forty carats each, and sometimes even larger.

Within a few years of Tavernier's visit to the Diamond Mines, the district must have been visited by an unknown European (perhaps as Ball suggested, Mr. Cholmley, who for some years purchased Diamonds for the East India Company) by whom a paper was sent to the Royal Society, and published in 1677, only one year after the appearance of Tavernier's first edition. In this paper the writer mentions no fewer than 23 Diamond Mines in the kingdom of Golconda, and 15 in the kingdom of Bijapur, or Visapur.

The Mallivully Diamond Mines, between six and seven hours' journey W.S.W. of Ellora, were visited by Heyne in 1795. The plain, on which the villages round about Mallivully lie, is on all sides surrounded by granite rock. The average depth of the alluvium in which the Diamonds are found is twenty feet. This alluvial deposit extends along the banks of the Kistna for the distance of about two or three hours' walk.

The change from a grey to a red soil, consisting of weather-worn granitic gravel, is here distinctly seen. The upper layer consists of the black "Cotton soil" brought down from the higher grounds by floods. Beneath this layer lies a mass of fragments of sandstone, quartz, jasper-flint, and granite, with great amorphous masses of calcareous conglomerate, but destitute of any indication of their having been rolled there by water. It is in this stratum that the Diamond is found; but none of the mines about Mallivully or Golapally are now worked.

The locality known as Parteal or Gani-Parteal, on the north bank of the Kistna, has been regarded by some authorities as the original home of the historical "Pitt" or "Regent" Diamond. The Hyderabad (Deccan) Company has for some years past been washing for Diamonds at Parteal or Partial. So important were the Diamond-workings in this district that by the Treaty of 1766, made between the Nizam and the East India Company, they were reserved to His Highness. The Diamond fields of Hyderabad have been visited and reported upon in recent years by several experts, as by Mr. Lowinsky in 1886, Mr. Theodore Hughes in 1887, and Mr. William Morgans in 1889.

The Diamond district of the Sumbulpur or Sambalpar group, in the Central Provinces, extends to the immediate vicinity of Sumbulpur, a city built on a fruitful alluvial table-land, 385 feet above the level of the sea, and situated between the rivers Mahanadi and Brahmini.

The Precious Stones which are found at the mouths of the little tributaries of the Maund, flowing from the north-east, are of various sizes and generally of the purest quality.

Although Diamonds are rarely, if ever, now found in Sumbulpur, it is interesting to preserve the description of the old Diamond-washers in the days of the Rajahs.

In Sumbulpur the Diamond seekers were of two castes. They resembled Negroes rather than Hindoos, and received the names of Ihara and Tora. Sixteen villages of the poorest kind were given up to them as free Jaghirs; ten being occupied by the Iharas and four by the Toras, the remaining two being dedicated to their gods.

These people were naturally superstitious. Nicolo Conti, who travelled in India in the early part of the 15th century, gives some very questionable stories as to a Diamond-producing mountain, and the means by which they were produced. It is also believed that sacrifices were made upon the opening of a new Diamond mine, and credulous travellers in those early days, might possibly have supposed that these sacrificial rites were essential to the successful search for Diamonds.

The Diamond seekers with their families, numbering from 4000 to 5000 persons, migrated yearly; and from November to the commencement of the rainy season searched the bed of the Mahanadi River from Chunderpur to Sonepur, a distance of twenty-four miles, scrutinizing every cleft and corner for the Precious Stones. They carried with them only three tools: a pickaxe, a board five feet long, hollowed in the middle and provided with a raised border three inches high, and a second board about half the size of the other.

With the pickaxe they scraped the earth out of the clefts and holes, and piled it in heaps on the bank. Their women laid the earth on the larger board, slightly inclined, washed it with water, and removed all the rougher sand and pebbles, which were subsequently placed on the smaller board, spread out, and searched for precious stones and gold dust. The Diamond was found for the most part in a mass of tough, reddish clay, pebbles, sand, and

some iron oxide. This seems to be the *débris* of the same stone "breccia" as that which Voysey supposed to be Diamond-rock in the Pennar and the Kistna groups. The washers of Sumbulpur now rarely, if ever, find Diamonds with the alluvial gold.

Another method of obtaining the Diamond was to form a flat surface in the neighbourhood of the place where the precious stones were to be sought, and build round it a wall two feet high, leaving here and there openings for the water to run off. The earth which had been worked out by means of the pickaxe, was thrown into this extemporized well, and after two or three washings the large stones were removed, the residue dried, and the Diamonds sought for. From time immemorial the Diamonds found in this district had been claimed by the ruler as his right. The finder of large Diamonds was rewarded by the royal grant of one or more small villages. For smaller Diamonds there were other rewards; but for the concealment of precious stones the natives were punished by having their villages taken from them, and were subject also to corporal punishment. In spite of this, and threatenings of severer penalties, smuggling and concealment continued.

Since the year 1818, Sumbulpur has been under British rule. In that year a Diamond was found which weighed 21 carats, and although of only the third quality was sold for 5000 rupees.

It is necessary to distinguish *Sumbulpur* in the Central Provinces from Tavernier's *Soumelpour*, a locality identified by the late Prof. Ball with Semah or Semulpur, on the River Koel, in Chutia Nagpur. Diamonds have also been worked a little further south, at a locality on the South River, one of the tributaries to the Brahmani.

In the Chanda district, to the south east of Nagpur, are the old Diamond mines of Wariagarh.

The Diamond-diggings in the immediate neighbourhood of Panna (or Punnah) in Bundelkhund, have been described by Mr. Medlicott, formerly Director of the Geological Survey of India. They do not cover an area of more than 20 acres. Great pits, 25 feet in diameter and, perhaps, 30 feet in depth, are dug for the sake of reaching the Diamond conglomerate, which, in many cases, is not more than a span in thickness. The miners enter the pit by means of inclined planes, and work almost naked and knee-deep in water. The material which they dig up is put into baskets and hauled by manual labour to the surface, where it is carefully searched for Diamonds. The most productive Diamond mines in this group were, in 1860, to be found in the village of Sukariuh, about twenty miles from Panna Here the upper stratum, from 15 to 20 feet thick, had to be broken through in order to reach the rich Diamond-bed which lay concealed underneath.

Four kinds of Diamonds were found at Sukariuh. They were termed, 1st, *Motichul*, clear and brilliant; 2nd, *Manik*, verging in tint towards green; 3rd, *Panna*, with a faint orange tint; 4th, *Bunsput*, sepia coloured.

Diamonds are found under the cascade of the river Bagin, from 700 to 900 feet below the present Diamond strata; and the only explanation hitherto given is that the Bagin has brought these precious stones down from the table-land, with other matter torn from its native bed.

Diamond-mining in India under European management does not appear hitherto to have been successful. It is erroneous, however, to suppose that there is any real exhaustion of the localities where mining is possible. On the contrary, geological examination has proved that the Diamond-bearing strata are very widely distributed; but it is doubtful whether the same working operations are

carried on in the more remote districts as in those nearer home. In fact, Diamond-mining will never be a success in India until the Government is prepared to grant long leases for the working, so as to enable the capitalist to get back money spent in machinery, without which no mine can be properly worked.

CHAPTER VIII.

RUSSIAN DIAMONDS.

It is believed that the first Russian Diamonds were found by a boy on June 22, 1829, at the Biszer Gold Washings, of the Countess Porlier, about 160 miles to the west of the town of Perm. Just at that time Humboldt was exploring the Urals, and his companions are said to have found Diamonds at the above mentioned locality.

The Krestovosdvigensk gold workings acquired some reputation for its Diamonds, and a portion was at one time worked exclusively for these stones. Altogether about 160 Diamonds were found, of which the largest weighed nearly 3 carats. Although several gold workings in the Urals have yielded Diamonds, it may be said generally that the gem is exceedingly rare in Russia.

The curious occurrence of diamantoid carbon in certain Russian meteorites has been referred to on p. 73.

CHAPTER IX.

UNITED STATES' DIAMONDS.

ALTHOUGH it has long been known that Diamonds are occasionally found in the United States, yet the quantity and the character of the stones hitherto discovered have not been such as to warrant any attempts at systematic working. The Diamonds occur mostly in the auriferous sands and gravels, and have been accidentally brought to light in washing the detritus for its gold.

In the Eastern States, Diamonds have been found very sparsely distributed through a belt of metamorphic rocks, along the east of the Appalachians, stretching through the States of Virginia, the Carolinas, and Georgia; whilst in the West they occur in California, and have also been discovered in Wisconsin, Oregon and Idaho. A comprehensive review of the general subject has been published by Mr. G. F. Kunz, of New York, in his work on "The Gems and Precious Stones of the United States."

Perhaps the most noteworthy Diamond hitherto yielded by the United States was one discovered in 1855, at Manchester, opposite Richmond, in the State of Virginia. It was found by a labourer at work in one of the streets, and was submitted by him to Mr. J. H. Tyler, sen., of Richmond, who at once pronounced it to be a valuable stone. It presented the form of an octahedron, with only a small single black spot in one of the solid angles, but it was off-coloured. In the rough it weighed

$23\frac{3}{4}$ carats, and after cutting weighed upwards of $11\frac{11}{16}$ carats. This stone has been called, after some of its owners, the "Dewey Diamond" and the "Morrissey Diamond."

The occurrence of itacolumite, or flexible sandstone, in North Carolina, led at one time to the conclusion that Diamonds might be found plentifully in that State, since it was believed by many mineralogists that a similar rock formed the matrix of the Diamond in Brazil.

One of the most prolific localities in the West has been the Cherokee District, in Butte County, California, where the gold miners on cleaning up the sluices occasionally find Diamonds. The stones are associated, as pointed out by the late Professor Silliman, with several rare minerals, including platinum.

About the year 1870, large discoveries of Diamonds were reported from Arizona, but it was eventually found that a gigantic fraud had been perpetrated, the ground having been liberally "salted" with rough Diamonds and other precious stones, such as Rubies and Sapphires, purchased in England for that purpose.

The interesting discovery of Diamonds in the great masses of meteoric iron from the Canyon Diablo, in Arizona, has been described on p. 73, in connexion with the discussion of the probable origin of Diamonds.

CHAPTER X.

COLOURED DIAMONDS.

DIAMONDS are found of almost every hue. The following is the order in which coloured Diamonds may be ranked, having regard to their rarity and value:—1, Red; 2, Green; 3, Blue; 4, Pink, 5, Mauve. There are undoubtedly fine specimens not included in this classification, their tints and shades being so peculiar and varied that they may better be described individually than in groups.

RED DIAMONDS.

Almost the only specimen of Red Diamond known to jewellers is a gem of a carat weight, bought by the author, and sold to the late Mr. George Samuel for £800. It is known as the "Halphen Red Diamond."

There are many Rose-coloured Diamonds, but the Blood or Ruby Red specimen just described—a gem on fire as it were—is believed to be unique in all modern experience. I understand, however, that a fine Red Diamond was found in Borneo, and sold, for a large sum, in Paris, but this was not of so deep a red as the Halphen.

GREEN DIAMONDS.

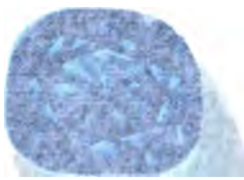
The history of the finest specimen of a Diamond of this colour may not be uninteresting. Fifty years ago this stone was thrown out of a parcel of Emeralds in

1

4

3

2



[illegible] Indian Rough Blue Diamond. 3. The [illegible] Diamond (Rose Cut).
[illegible] Blue Diamond (Brilliant Cut). 4. The "P[illegible]" [illegible] Diamond (Brilliant Cut).

2, 3, [illegible] Cut from French Blue [illegible]

CHAPTER X.

COLOURED DIAMONDS.

DIAMONDS are found of almost every hue. The following is the order in which coloured Diamonds may be ranked, having regard to their rarity and value:—1, Red; 2, Green; 3, Blue; 4, Pink; 5, Mauve. There are undoubtedly some specimens not included in this classification, their characteristics being so peculiar and varied that they may better be described individually than in groups.

RED DIAMONDS.

Almost the only specimen of Red Diamond known to jewellers is a gem of a carat weight, bought by the author and sold to the late Mr. George Samuel for £800. It is known as the "Halphen Red Diamond."

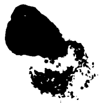
There are many Rose-coloured Diamonds, but a Blood or Ruby Red specimen just described—a gem as free as it were—is believed to be unique in all modern experience. I understand, however, that a fine Red Diamond was found in Borneo, and sold for a large sum in Paris, but this was not of so deep a red as the Halphen.

GREEN DIAMONDS.

The history of the finest specimen of a Diamond of this colour may not be uninteresting. Fifty years ago the stone was thrown out of a parcel of Emeralds in

1

4



3

2

TAVERNIER INDIAN ROUGH BLUE DIAMOND.

THE "HOPE" BLUE DIAMOND (Brilliant Cut).

3. THE "BRUNSWICK" BLUE DIAMOND (Rose Cut).

4. THE "PIRIE" BLUE DIAMOND (Brilliant Cut).

2, 3, 4, Cut from French Blue Brilliant.

Vienna and bought for a trifle by the late Mr. George Samuel, at that time Consul there, who sold it to the author for £200. Some years afterwards, it was sold for £300. Subsequently it passed into the possession of a jeweller in Bond Street, who sold it to an American for £600, and afterwards, it was sold for over £1,000 to a great New York jeweller, and I understand it has since been sold, for something like 7,000 or 8,000 dollars.

Among the treasures of the famous Grüne Gewölbe, or "Green Vaults," of Dresden, is a pale Green Diamond weighing 48½ carats, and valued at £30,000. It is not, however, to be compared, in respect of colour, with the green one mentioned above, and is indeed more of the colour of an aquamarine.

The collection of coloured Diamonds in the Vienna Museum, which was brought together by Herr Virgil von Helmreicher, a Tryolese by birth, but long resident in Brazil, is undoubtedly the most complete in Europe.

BLUE DIAMONDS.

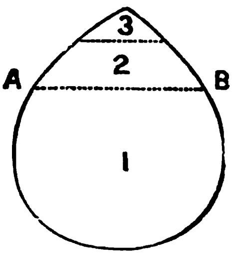
Diamonds of a faint bluish tint are not unfrequently found, but their defect is that they are usually more or less opalescent, and therefore they formerly ranked as stones of inferior quality, though they now realize high prices in America.

The only Blue Diamonds known until lately were found in the old Indian mines, probably those of Gani-Colour, visited by Tavernier, and the first mention we have of a Blue Diamond in Europe refers to a stone then considered unique. It weighed in the rough 112¼ carats, was bought by Tavernier in India in 1642, and was sold to Louis XIV. in 1668. It is described as "d'un beau violet." It would

appear to have been somewhat flat and ill-formed. The figure given in our plate probably represents faithfully this stone in its condition at the time, and is a copy from an old French engraving. After its purchase by "Le Grand Monarque," it was apparently cut. It figured in a grand historic scene on the 19th February, 1715, when the Persian Ambassador appeared before Louis XIV., twelve days after his public entry into Paris. Le Grand Monarque, notwithstanding his great age and infirmities, exerted his remaining energy of will to appear before the illustrious stranger to the best advantage. He was dressed in a black suit, ornamented with gold, and embroided with Diamonds stated to cost—the almost incredible estimate of £12,000,000. Suspended from a light blue ribbon round his neck, he wore a dark Blue Diamond as a pendant. And we find in the French regalia, a century later, a facetted Diamond, triangular in shape, and of an identical colour, weighing 67⅛ carats, which would be about the weight of Tavernier's celebrated purchase, after it had been cut.

This stone was, with the rest of the French regalia, seized in August, 1792, and deposited in the Garde-Meuble. From this insecure place it was surreptitiously abstracted in September of the same year. What ultimately became of it remains a mystery. That it should have really been lost is incredible; and from the sudden appearance of a stone of similar character, the extraordinary rarity of which is acknowledged, the belief may be fairly entertained that the new stone was only Tavernier's gem re-cut, and so altered in form as to render its identification very difficult. This hypothesis receives additional probability from the fact that a Blue Brilliant about the year 1830, was in the hands of Mr. Daniel Eliason, which

came to light without a history, without any account being rendered as to whence it came, and what had been its travels and fortunes. Subsequently it is traced as the property of the late Mr. Hope, under the name of the "Hope" Diamond. The difference in weight between the original stone of 67⅛ carats, and this actual stone of 44¼ carats, naturally suggests the question, "Was the weight lost simply in the cutter's hands, or were one or more pieces removed by simple cleavage, and preserved?" The latter supposition, viz., that the Diamond abstracted in 1792 was reduced by cleavage and formed into three Brilliants, is not improbable. This deduction is indeed the more plausible, as Tavernier's Diamond evidently had one of the crystallographic faces *largely produced* on the one side, which gave the stone a "drop form," a formation frequently seen in rough Diamonds, especially in coloured stones (excepting always the yellow varieties), and leading to the inference that the cleavage plane must have lain as in the diagram between A and B. In the first cutting of the stone this original shape was to some extent preserved, which left an ill-formed, triangular-shaped Brilliant somewhat thin on one side. From this it would have been easy for an expert to cleave a triangular piece of about 10 or 11 carats, thus leaving the stone weighing about 56 carats, the re-cutting of which, as a perfect Brilliant, well proportioned, would reduce it to its present weight of 44¼ carats. It is observable that the "Hope" Diamond is even now straighter on one side than the other, and this strengthens the presumption of the stone having been cleaved as suggested.



(See Coloured Plate of Blue Diamonds for shapes).

The correctness of this hypothesis would receive confirmation if the pieces, or the piece, assumed to be split off could be discovered and identified, but the difficulty in the way of this evidence lies in the strong presumption of *remanets* having been also subjected to re-cutting and re-polishing. The cleft-off piece must have been triangular at first, with a straight side corresponding with the side of the "Hope" Diamond, as shewn in the diagram. After being re-cut it would make a Blue Diamond of "drop shape," the base of which would correspond with the straight side of the latter gem, proportionate in substance, identical in colour (in all probability) and weighing from 6 to 7 carats.

A stone answering to such a description would supply strong presumptive evidence in support of the theory, that the two stones would be part of the one originally separated by the cleaver's art; and such a stone did actually come into the market in April, 1874, and fell into the hands of some competent judges, who examined it in juxtaposition with the "Hope" Diamond, to which, in colour and quality, it bore a remarkable resemblance. It was purchased in Geneva at the sale of the late Duke of Brunswick's jewels. The conclusion that the Duke of Brunswick's "Blue Drop Diamond" once formed the projecting side which appears to have characterized the original shape of the "Hope" Brilliant was inevitable, and I bought the third piece in Paris for £300; it weighed 1 carat, and was of identically the same colour, thus quite accounting for the Blue Diamond stolen in 1792. This will be understood by reference to the figure on the last page. No other Diamond of this dark Sapphire steely-blue colour has to my knowledge ever been discovered.

There are Diamonds of other colours, such as pink, mauve and brown-red, which fetch high prices; but of the red, green and blue varieties, nothing has ever been found to touch the three which I have mentioned above. Strangely enough I have sold the red once, the green twice, and the blue once; the last having been sold to the late Emperor of Russia, father to the Duchess of Edinburgh, though the trustees in custody of the Diamond would not, for family reasons, at that time deliver it.

CHAPTER XI.

BORT.

CERTAIN Diamonds are found of inferior quality, and so imperfectly crystallized, that they are useless as ornamental stones. These are called "Bort," or "Boort," and are either crushed to form Diamond dust, or are used for engraving. By mineralogists the name *Bort* is restricted to a form of Diamond, which generally presents the appearance of small nodules or spherical masses, rough on the outside, and destitute of cleavage, but displaying on fracture a radiated internal structure. It is usually greyish white, or of a dark or even black colour, and has a density a trifle less, but a hardness decidedly higher, than that of ordinary Diamond. Under the microscope it shows a confusedly crystalline structure.

The best kind of Bort, the round, is now used as an abrasive in rock-boring, and when suitable fetches even a higher price than the cutable Diamond, the supply not being equal to the demand. Much Bort, too, is crushed in steel mortars and used in the form of powder. This powder, as well as that which is the produce of the operations of cutting and cleaving rough stones, is after mixture with oil, employed for polishing Diamonds, Rubies, Sapphires, and other gems.

CHAPTER XII.

CARBONADO.

THIS substance, also known as "*Carbonate*" or "*Carbon,*" was discovered in Brazil in 1845, and occurs in small irregular masses of a dark grey, or even black colour. Both the names, Carbonado and Carbonate, are clearly misnomers, as chemically, the body referred to is, like Diamond, Graphite, and Charcoal, a form of the element Carbon. It appears to consist of an irregular aggregate of small crystals, and presents on fracture a granular or crypto-crystalline structure. It is found in Brazil, mostly at Chapada, in the province of Bahia; and in the island of Borneo; but has not been found either in India or at the Cape. Carbonado though of slightly less density than the ordinary Diamond, is immensely superior to it in hardness. It is, in truth, the hardest known substance in nature, surpassing even Bort, which, in its best varieties, is a trifle harder than the Diamond.

Carbonado was at first introduced for the purpose of cutting Diamonds, after the same fashion as Bort. During the last 25 years, however, a new and most impoitant application of this material has been made. It is now very extensively employed for the purpose of drilling holes in rocks, either to receive explosives for subsequent blasting, or for prospecting, in order to discover their underlying strata. The demand that has thus sprung up for

Carbonado, in operations for gold-mining and other purposes, has caused it to rise in price from 2*s.* 6*d.* to £8 or even to £10 per carat.

THE DIAMOND DRILL.

If steel is used to cut rocks, a percussive and not a rubbing or cutting motion must be given to it; otherwise, owing to its deficient hardness, the steel itself would be worn away rather than the rock, as popularly exemplified in the ordinary grindstone. Where deep borings for exploring purposes have to be made, it becomes a difficult mechanical problem to construct a machine, which shall satisfactorily impart a striking motion to a heavy steel tool. Moreover, the difficulties and chances of failure increase very rapidly with the distance from the surface, whereas, with a continuous rotatory motion, it is comparatively easy to bore to any depth. Borings have been effected to a depth of several thousand feet with the aid of carbon, not much greater difficulty being experienced at the end than at the commencement of the operations.

Selected pieces of carbon are firmly embedded in a ring of steel, called a crown, of the size corresponding to that of the perforation which it is desired to bore. This ring is screwed to a series of long hollow tubes, which are lengthened as the work proceeds; these tubes or rods are kept rotating by steam power, and their weight is so adjusted, that a pressure of half a ton can be brought to bear on the crown, when it is boring a 4-in. hole in native or living rock. The crown rotates some 250 times a minute, and water is continually pumping through the hollow rods, passing under the cutting face of the crown, to keep the Diamonds cool, and to wash off and upward

to the surface, the *débris* formed by the action of the crown. Under favourable circumstances hard granite would be readily cut at the rate of 3 in. to 4 in. per minute.

The Diamond apparatus does its work entirely by friction. Its action is simply an abrading one, and effected neither by cutting nor percussion. It grinds or crushes the rocky stratum by its adamantine density. The difference between the relative hardness of the Carbonate and ordinary rock is such, that several thousand feet might be bored with a crown properly set with good stones, before any serious wear would take place. The principal loss does not result from actual wear, but from the breakage which is caused when one of the stones becomes loose in its setting, or from some accidental cleavage which occurs; the fragments, unable to escape from beneath the crown, invariably injure the other stones.

CHAPTER XIII.

VALUE OF ROUGH DIAMONDS.

THE valuing of rough Diamonds requires much technical experience, and is quite a business of itself.

Although the Diamonds of all parts of the world possess certain characteristics in common, yet the stones from different places have special peculiarities by which good judges generally find themselves at once in a position to declare the locality whence they have been obtained, although they cannot always define the grounds of their judgment.

In valuing rough Diamonds it is necessary to consider the following points: firstly, the form and proportions of the crystal, whether it can be cleaved to advantage; and then the loss of weight likely to be incurred in cutting, as an irregular or broken piece obviously requires a greater sacrifice of weight to form it into a perfect Brilliant than a well-proportioned crystal. The best forms to choose are the octahedron and the rhombic dodecahedron. Chips or splints are often fashioned by the cutter with very little loss of weight. Secondly, heed must be taken to distinguish the degrees of colour, and purity of the specimen.

It must not be forgotten, in estimating large Rough Diamonds, especially those from the Cape, that certain tints of colour may be brought out in the cutting, which do not appear in the stone in its rough state; thus, perfect polish, and the power of reflection, characteristic of the

Brilliant, intensify any tint of yellow existing in the stone. This observation does not apply to river stones, but rather to those from the dry diggings. In many specimens a spot is developed after cutting, which was not visible in the rough. This spot may appear even in the finest Diamonds, and is especially noticeable in Indian stones.

It is impossible to quote a standard price for Rough Diamonds since the price is subject to much fluctuation. The remark universally applicable is that the value varies greatly, according to the size, the shape, the colour of the stone, and its freedom from flaws.

CAPE ROUGH DIAMONDS.

To those who are not conversant with the various classes and details of the sub-division of Rough Diamonds, the following classification may be of service :—

White Clear Crystals.
Bright Black Cleavage.
Cape White
Light Bywater.
Large White Cleavage.
Picked Melée.
Common and Ordinary Melée.
Bultfontein Melée.
Large White Chips.
Small White Chips.
Mackel or Macle (flat for roses).
Bright Brown.
Deep Brown.
Bort.
Yellows.
Large Yellows and Large Bywaters.
Fine Quality River Stones.
Jagersfontein Stones.
Splints.
Emden.
Fine Fancy Stones.

SECTION III.

COLOURED PRECIOUS STONES.

CHAPTER I.

THE RUBY.

THE Ruby not only stands in the very foremost class of coloured gems, but it occupies among Precious Stones in general a position which is unquestionably supreme. By the Ancients it was regarded as the very type of all that was most precious in the natural world ; and its value is amply attested by the numerous allusions to it in the Old Testament, sometimes under the name of Jasper.

The price paid for this stone by the Ancients was very high. According to Benvenuto Cellini, in his time a perfect Ruby of a carat weight cost 800 ecus d'or, whilst a Diamond of like weight cost only 100. Even at the present day a fine Ruby of 5 or 6 carats may be worth ten times the value of an ordinary white Diamond of equal weight ; for the former is very difficult to obtain, whilst the latter may be readily procured.

Although it is not always easy to distinguish in ancient writings between the description of the Ruby and

that of other red stones, it is yet believed that the *Anthrax* of the Greek Philosopher Theophrastus must have been the mineral which we recognise as Ruby; whilst the *Carbunculus* of Pliny probably included this and other stones of a somewhat similar character. The Anthrax was so called in allusion to its vivid colour, suggestive of that of a live coal, and the word Carbunculus likewise referred to its fiery appearance. Of the various kinds of Carbunculus known to the Ancients, the most valuable was that termed *Lychnis*, in consequence of its lustre resembling that of a lamp. It is curious to note that many old writers seem to have believed in the self-luminosity of the Ruby and other red stones. Thus, the quaint old writer Sir John Maundeville, describing his travels in the East in the fourteenth century, says with regard to the many marvels of the Court of the Great Chan of Cathay, "This Emperor hath in his chamber, in one of the pillars of gold, a Ruby and a Carbuncle of half-a-foot long, which in the night gives so much light and shining, that it is as light as day." This statement however may be laid to rest with the numerous other travellers' stories to be found in the pages of the credulous old knight.

Before Mineralogy became a science, and could call to its aid the services of Chemistry and Physics, it was by no means surprising that various stones of red colour should be confounded together; thus the Spinel or Balas, and the Garnet were often mistaken for the true Ruby. The only stone, however, to which the term Ruby in scientific strictness can be applied is a variety of the mineral-species termed *Corundum*.

The name Corundum is derived from the Hindu word *Kurand*, and it is most probable that it first became known in Europe from the stone having been imported from

India. Corundum occurs in a great variety of conditions, some being coarse and opaque, while others are translucent or transparent, but it is only the latter which take rank as gem-stones, and can be used for jewellery.

All forms of Corundum are found by the chemists to contain more than half their weight of the metal, *Aluminium.* The oxide of this metal is called *Alumina*, and it is this substance which, in its natural state, forms the mineral Corundum. As a silicate, Alumina forms the basis of all clays, and a multitude of other common minerals and rocks; while as a sulphate it enters into the composition of *Alum* —whence indeed the word "Alumina" is derived.

The coarse varieties of Corundum are more or less impure, but the transparent crystals exhibit the Alumina in a state of approximate purity—being uncontaminated with any other substance, save perhaps a trace of certain metallic oxides, on which the exquisite tints of the coloured Corundums depend, but which are present in such minute quantity as well-nigh to elude the vigilance of the chemist.

Those Corundums which present a red or reddish colour are the true Ruby—this stone being sometimes described in works on mineralogy as the *Oriental Ruby*, in order to distinguish it from such stones as the Spinel and others. The main fact to be borne in mind with respect to the distinctive character of the Ruby, from a mineralogist's point of view, is that it is really *a variety of crystallized Alumina.* It will be shewn in a subsequent part of this work that the Sapphire has practically the same chemical composition and the same physical characters, the difference between these stones being mainly one of colour. It is believed that the fine colour of the Burma Ruby is due to the presence of oxide of chromium, associated in very small proportion with the alumina.

When Tavernier in his famous "Travels" describes the Ruby of Pegu, he says: "All other coloured stones, in this country are called by the name *Ruby*, and are only distinguished by colour; thus, in the language of Pegu, the Sapphire is a Blue Ruby." With reference to this passage, the late Prof. Ball, in his edition of the "Travels," remarks in a note; "A very legitimate system of nomenclature, as they are all of the same chemical composition, viz; alumina or corundum."

Corundum, in all its varieties, crystallizes in the hexagonal system, usually in double six-sided pyramids, but often also in hexagonal prisms, and sometimes in six-sided plates or tabular crystals. The crystalline character of the Ruby furnishes, even in a cut stone, a ready means of distinguishing it from Garnet or from Spinel; since the crystalline structure is closely correlated with certain optical properties. The use of the instrument called the *dichroiscope* renders the distinction a matter of certainty. This instrument enables us to see whether the gem possesses the property of dichroism—that is, of exhibiting two distinct colours, or tints, when viewed in different directions. Gems belonging to the Cubic system of crystallization do *not* exhibit this property, while in those belonging to any of the other systems this diversity may often be detected, when properly examined by the dichroiscope, be the stone ever so uniform in colour to the unassisted eye. Since both the Spinel and the Garnet belong to the Cubic or Tesseral system, they display *no* dichroism, whereas the Ruby, which belongs to the Hexagonal system, is invariably dichroic. The typical Burma Ruby when examined by the dichroiscope, exhibits one image of crimson, while the other is an aurora-red colour.

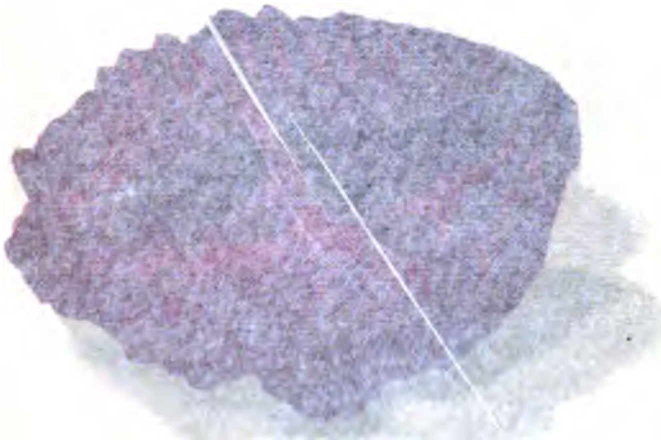
The colours of the Siam Ruby are different, being crimson and brownish-red.

The crystals of Corundum, including those of Ruby and Sapphire, are often ill-shaped and rough, and usually very much rolled. The cleavage is accompanied by conchoidal and uneven fracture, and by brittleness. The lustre of Corundum is vitreous, but sometimes pearly on the basal planes, and the crystals, when properly cut, occasionally exhibit a bright opalescent star of six rays in the direction of the principal axis. Such crystals form the *Star Stones,* to be noticed in a subsequent chapter.

The refractive index of Corundum is 1·77, and therefore higher than that of glass; hence the great brilliancy of the Corundum gem-stones, when properly cut and polished. Sir W. Crookes has shown that the Ruby, when exposed to electric discharge in high vacuo, phosphoresces with a brilliant red glow.

All varieties of Corundum can be scratched by the Diamond, but by no other mineral. The extreme hardness of Corundum has suggested its mineralogical name of *Adamantine Spar*; and it seems likely that the *Adamas* of early Greek writers was not the true Diamond, but merely a form of Corundum.

Although Corundum is a mineral which, in its various forms, enjoys a fairly wide geographical distribution, it is remarkable that the fine red varieties are extremely rare and restricted in their occurrence. The localities yielding the Rubies of commerce are indeed practically limited to Burma, Siam and Ceylon. Even of these localities, it is only Burma that has acquired celebrity for the favourite tint, the true pigeon's-blood colour, which always obtains the highest price in the market. The Rubies of Siam are generally too dark, and those of Ceylon too pale.



BURMA RUBY.

(Weight, [illegible] Carats)

The colours of the Siam Ruby are different, being crimson and brownish-red.

The crystals of Corundum, including those of Ruby and Sapphire, are often ill shaped and rough, and usually very much rounded. The cleavage is accompanied by conchoidal and uneven fracture, and by brittleness. The lustre of Corundum is vitreous, but sometimes pearly on the basal planes, and the crystals, when properly cut, occasionally exhibit a bright opalescent star of six rays in the direction of the principal axis. Such crystals form the *Star Stones* to be noticed in a subsequent chapter.

The refractive index of Corundum is 1·77, and therefore [illegible] than that of glass; hence the great brilliancy of [illegible] stones when properly cut and polished. [illegible] has shown that the Ruby, when exposed [illegible] discharge in [illegible] vacuo, phosphoresces with a [illegible] glow.

All varieties of Corundum can be scratched by the Diamond, but by no other mineral. The extreme hardiness of Corundum [illegible] its mineralogical name of *Ad[illegible]* [illegible] and it seems likely that the *Adamas* of [illegible] was not the true Diamond, but [illegible] Corundum.

Although Corundum is a mineral which, in its various forms, [illegible] wide geographical distribution, it is remarkable [illegible] the fine red varieties are extremely rare [illegible] in their occurrence. The localities yielding the [illegible] of commerce are [illegible] practically limited to [illegible] and Ceylon. [illegible] of these localities, it [illegible] that has acquired celebrity for the favourite [illegible] colour which always obtains [illegible] in the market. The Rubies of Siam are [illegible] too dark, and those of Ceylon too pale.

BURMA RUBY.
(Weight, 1184 Carats).

BURMA RUBIES.

Up to the time of the annexation of Upper Burma to the British Empire, in 1886, no description of the Ruby district had been written by an Englishman; and the only accessible account of the mines was one by the Padre Guiseppe d'Amato, an Italian Jesuit Missionary in Burma, whose description was published in the "Journal of the Asiatic Society of Bengal," for 1833.

Within the last few years, however, our knowledge of the subject has grown rapidly, and at present we are in possession of so large a body of information respecting the character of the country and the working of the mines that the next chapter of this work will be devoted to these subjects. It is therefore, unnecessary in the present place to enter into full details.

From enquiries made on the spot in 1888 by Mr. F. Atlay, who was for some time the author's representative at the mines, and is now the local sub-manager for the Burma Ruby Mines Company, Ltd., it appears that there is a tradition to the effect that the Ruby-tract, including Mogok, Kathe and Kyat-pyin, formerly belonged to Momeit; and that the Burmese at that time knew nothing about the occurrence of Rubies. It happened in the year 1630 that a Burman came to Mogok with tamarinds for sale; and having obtained a red stone in exchange for some of his fruit, presented this to the King of Ava The king was so pleased with the Ruby that he entered into negotiations for the tract of country which produced such minerals; and in the year 1637, he peacefully obtained the Ruby district in exchange for other territory.

The Ruby mining district consists geologically of various kinds of the foliated rocks called gneiss, associated with certain granitic rocks, and interstratified with bands

of crystalline and saccharoidal limestone. The structure of the country has been described by Mr. C. Barrington Brown, whilst the petrology of the Ruby rocks has been carefully worked out by Prof. J. W. Judd, C.B. The matrix, or parent rock of the Ruby seems to be the limestone, which in some cases is boldly crystalline and in others finely granular. With this limestone are associated certain basic rocks, such as those known technically as pyroxenites and amphibolites. It is suggested by Prof. Judd that the limestone has probably been produced by the metamorphism of the lime-bearing felspars in the basic crystalline and foliated rocks. The felspar may be first altered to scapolite; and from this rather unstable mineral, carbonate of lime may eventually be formed; at the same time the aluminium silicates of the felspars, being decomposed by natural acids, have suffered decomposition, with final production of alumina. This alumina, under certain conditions of temperature and pressure—the latter being apparently very great—has crystallized out as corundum, which takes exceptionally the condition of Ruby. The Ruby is thus found, with other minerals, embedded in the limestone as a matrix.

By the disintegration of the matrix, the Rubies and Spinels have been set free; and are now largely found, as rolled crystals and derivative fragments, among the detrital matter which is abundantly distributed over the valleys, along the hill-sides, and on the floor of the limestone-caverns. A brown or yellowish clay, known locally as *Byon*, seems to be the typical Ruby-bearing earth.

In 1887, when working the mines, and before the Company was formed, the author obtained from Burma a curious rough Ruby, weighing 49 carats, and consisting of a flattened aggregate of ill-defined crystals. Between

some of the component crystals there was a want of continuity, giving rise to an aperture which looked like an artificial perforation through the stone.

The occasional discovery of a very fine Ruby, is recorded in the annals of Burma mining. "Gnaga Boh," or The Dragon Lord, is the name given to a Ruby found at Bawbadan, weighing in the rough 44 carats, and when cut 20 carats. This stone, which is said to be the finest of its size ever seen, was given by the finder to King Tharawadis.

Another very fine stone, weighing in the rough 100 carats, was found on Pingudoung Hill soon after Theebaw ascended the throne, and was presented to him by Oo-dwa-gee, at that time Woon of the Ruby Mining district. As several "royal rubies" have at various times been found on this hill, the Company established workings there, which gave at first much promise of success, but afterwards turned out very disappointing.

The two most important Rubies ever known in Europe, were brought to this country during the year 1875. One was a rich coloured stone, cushion-shaped, weighing 37 carats; the other, a blunt, drop shape, of 47 carats.

It was deemed advisable to have these stones re-cut; and the work was entrusted to the late Mr. J. N. Forster, of London, who re-cut the stone of 37 carats to $32\frac{5}{16}$, and the one of 47 carats to $38\frac{9}{16}$. They were much improved thereby, and competent judges pronounced them the finest stones of their size yet seen, the colour being truly magnificent. The smaller stone of the two was sold abroad for £10,000; the larger one found a purchaser on the Continent for £20,000. The fact of two such fine gems appearing contemporaneously is unparalleled in the history of Precious Stones in Europe. It is questionable,

however, if the London market would ever have seen these truly royal gems but for the necessities of the late Burmese Government. In Burma the sale of these two Rubies caused intense excitement, a military guard being considered necessary to escort the persons conveying the package to the vessel. Two such Rubies are not to be found in any European regalia.

There are, however, some very celebrated and historical Rubies still on record. For example one of the size of a pigeon's egg in the Russian Regalia was presented to the Empress Catherine by Gustavus III. of Sweden, when on a visit to St. Petersburg, in 1777. Chardin speaks with admiration of a Ruby cut *en cabochon*, of great beauty, and of the size and form of half an egg, having the name of "*Thelk Lephy*" engraved on the end.

It is known that the great historical gem in the Imperial State Crown in the Tower of London, known as "The Black Prince Ruby," is not a Ruby, but a magnificent Spinel. It is cut *en cabochon*, and has a hole drilled through it, now filled up by a plug of similar stone. This gem was presented to the Black Prince by Don Pedro, the cruel King of Castile, and was worn in the helmet of King Henry V. at the battle of Agincourt.

The finds of really remarkable Rubies in Burma have not been numerous in the past few years, either by the Company, or by native licensees. The Company have of course, found many valuable and fine stones, but only one of truly surpassing excellence; this was a Ruby found in the Tagoungnandaing mine in January, 1895, and weighed in the rough $18\frac{7}{16}$ carats; the few Burmans to whom it was shown said it was the finest stone they had ever seen, and the experts in London were equally delighted with it.

In the summer of 1895, a Ruby weighing 973 carats was found by a Burman miner in the Ingouk valley close

to Mogok, the actual spot where it turned up being only 8 to 9 yards away from the author's original mine. This stone is not at all pure, parts of it being thick and cloudy, but at the same time a good deal of it is undoubtedly of fine quality; lying on the table in the bright sun, it has a wonderful glow; no idea of its value can by given, for it is impossible to say who would buy it, but it is a most wonderful stone, and its lucky owner dreams of untold wealth. Though not quite as large as the 1183 carat Ruby, of which an illustration is here given, it is of infinitely superior quality.

Calcutta is the great market for Rubies of second class and lower quality, but the fine stones almost without exception are sent direct to London. For further information regarding the Burma Rubies the reader is referred to the next chapter of this Section, which deals specifically with the Ruby mines of Burma.

SIAM RUBIES.

It has been known for many years that Rubies occur in Siam, but it is only in recent years that they have been systematically worked. Mr. John Crawfurd in his well-known account of the Embassy to the Court of Siam, in 1828, states that Rubies are found in the hills at Chantaboon, and that the working of the stones is a Royal Monopoly, rigidly guarded; but he adds that the Siam Rubies are "much inferior in quality to the Ava Stones."

Mr. H. Maxwell Stuart, a gentleman of high authority on Precious Stones, who went to Siam to obtain the concession of certain mines, enquired with much care into the conditions under which the Rubies and Sapphires occur. He admits that the greater number of the Rubies in Siam

are of dark colour, but considers that "many individual stones may be said to rival the best Burma Rubies." In this opinion, the author, after much experience in dealing with Rubies, both from Burma and Siam, fully concurs.

The Ruby mines of Siam are chiefly situated in the Provinces of Chantaboon and Krat, and can be reached by steamer from Bangkok in less than twenty hours. Rubies are also found in the Sapphire mines of Battambong. It appears that the higher parts of the mountains in these districts consist of greyish granite, and that the rest of the country is largely composed of limestone. The precious stones occur in detrital matter, and have been worked in a primitive manner by means of pits, none of which exceed 24 feet in depth. The workings in the Province of Krat have been visited and reported on by Mr. Dimetri, from whose report some of the following details are taken:

The Ruby mines in that province consist of a large number of workings in two principal groups, about 30 miles from each other, known as the mines of Bo Navong and Bo Channa. The Bo Navong mines, covering an area of about 2 square miles, include thousands of holes, two to four feet in depth, near the village of Ban Navong. A coarse yellow or brown sand, forming the surface of the country, rests on a bed of clay, and at the junction is the Ruby-bearing gravel, forming a stratum from six to ten inches thick. The Bo Navong mines have been worked for the last five-and-twenty years, and the Rubies which they have yielded are of a finer quality, though usually smaller, than those of the other workings. The group of Bo Channa mines is situated about thirty miles in a north-easterly direction from Bo Navong.

An excellent description of the Ruby-mines has recently been published by Mr. H. Warington Smyth, who

was for some years Director of the Department of Mines in Siam. He considers that the Rubies have probably been derived from the disintegration of certain basaltic rocks, which formed their matrix. The principal Ruby-workings are now at Bo Wen and Taphan Hin, in Chantaboon; and at Bo Yan, Navong and Klong Kwang, in Krat. Rubies are also worked at Ho Klong, Klong Yai and elsewhere, on the east side of the Kao Patat.

Prof. H. Louis has also described the Ruby deposits of Moung Klung, between Chantaboon and Krat. He considers that the gem stones have been derived from the decomposition of the trap rocks, which occur so largely in the district.

The Sapphires, which are of far more importance in Siam than the Rubies, will be fully described in a subsequent chapter.

CEYLON RUBIES.

From time immemorial the island of Ceylon, or "Taprobane" as it was termed by the classical writers of antiquity, has been famous for precious stones. These are found in the form of rolled crystals and rounded fragments in detrital deposits in the valleys, spread over the lowlands, and in the sands of rivers. Shallow pits are dug by the natives in these deposits, and the gem stones separated from the associated earth by simply washing. The principal localities for the stones are in the neighbourhood of Ratnapura, or the "City of Gems," and Rakwena. The gem-stones include various kinds of coloured Corundum, but Sapphires are much more common than Rubies. Moreover, the Ceylon Rubies are usually of pale colour, being rose-coloured rather than decidedly red, are of only small value, and are, in fact generally spoken of as fancy coloured Sapphires.

RUBIES FROM OTHER LOCALITIES.

Although Burma, Siam and Ceylon are the only countries which have hitherto yielded Rubies in quantity of any commercial importance, it must be remembered that red or reddish Corundum has been found in many other localities, and it seems likely that the Ruby enjoys a wider geographical distribution than is generally admitted.

At Jagdalak, 32 miles east of Kabul, Rubies were systematically worked by the Amir of Afghanistan. In 1879 the mines were visited by Major G. Stewart; and from specimens supplied by him, it appears, according to Mr. F. R. Mallet, that the Ruby occurs there in a white crystalline micaceous limestone.

Major Moriarty, on his return from Cabul, brought to this country a Ruby, weighing 10½ carats, from the mines of Gandamak, in Afghanistan, which are situated about 30 degs. N. lat., and 70 degs. E. long.

From Thibet the author on one occasion received a large piece of rough Ruby, weighing 2000 carats, forming a flattish slab, measuring on one face 3 inches by 2½ inches. It was, however, opaque and silky, and when cut yielded only Star Stones. Rubies have also been found in the Mysore district, and some cut by the author's directions have turned out bright stones, but of small size, and of no value; the principal part being only Corundum.

Rubies of small size and of very little value have occasionally been found in some of the tin and gold-bearing gravels of Australia. In New South Wales they are recorded from the Cudgegong and some of its tributaries, and from Mudgee and a few other localities. In Victoria the Ruby occurs in the drifts of the Beechworth gold-fields, at Pakenham, and elsewhere. A magenta-coloured Corundum, more or less opaque, is known in Victoria under

the name of *Barklyite.* On the whole, the red Corundum is far rarer in Australia than the blue Corundum; and the same rule holds good in many other localities, the Ruby being rarer and therefore more prized than the Sapphire.

The so-called "Rubies" from the Macdonnell Ranges in the Northern Territory of South Australia, the discovery of which created great excitement a few years ago, are nothing but Garnets.

Among the precious stones of the United States of America, coloured Corundums are included. A remarkable deposit of Corundum, associated with Ruby and Sapphire, was described by Col. C. W. Jenks, before the Geological Society of London in 1874. The locality is known as the Lucas Corundum Mine, and is situated in Macon County, North Carolina. The Corundum, associated with numerous other minerals, occurs in veins, running through a mass of serpentine, which, rising as a boss through the surrounding granite, is known as Corundum Hill. Some of the crystals yielded by these veins weighed more than 300 lbs. each, and many of them exhibited a curious diversity of colour, so that one part of a crystal might be red, while another portion of the same mass would present blue and green colours. The brightly coloured portions were veritable gems, but mostly too much flawed and otherwise too imperfect to be of value as ornamental stones. The discovery was one of considerable mineralogical interest, but of no importance in connection with the production of precious stones for jewellery.

ORIENTAL RUBY.

Composition	Alumina.
Specific Gravity	4.
Hardness	9, or slightly under.
System of Crystallization ...	Hexagonal.
Form...	Six-sided prisms and pyramids, variously modified, but usually as rolled fragments.

CHAPTER II.

THE RUBY MINES OF BURMA.

ALL attempts to lift the veil of mystery which had enshrouded the famous Ruby Mines of Burma, since the time when they were first brought to the knowledge of Europeans in the fifteenth century, had been utterly fruitless until after our formal annexation of Upper Burma, in the beginning of 1886. Up to that time we were profoundly ignorant of the conditions under which the gem-stones occurred in this inaccessible country; the mines having been jealously guarded from Europeans, and rarely if ever, visited by anyone possessing a competent knowledge of mineralogy. Soon after the annexation of Upper Burma, the author of this work, under circumstances which will be fully explained subsequently, applied to the Indian Government for a concession of mining rights in the newly acquired territory. During the negotiations, his son, Mr. George Skelton Streeter, Mr. C. Bill, and Mr. Beech, were permitted to accompany the first military expedition to the Ruby mines. In *Murray's Magazine* for May, 1887, an article was published on the subject, which had peculiar interest, since it was written at the mines, and was the first description which had ever appeared from the pen of any European expert in gems, personally acquainted with the stones and with the district.

Much of the following description of the mines, is from the pen of Mr. W. S. Lockhart, C.E., who resided at

the mines for nearly two years as Engineer-in-Chief to the Burma Mining Company, Ltd., and thus obtained a very intimate knowledge of the native methods of working.

The Ruby-mines District of Upper Burma is a large political division, bordering on the left or eastern bank of the Irrawaddy, but the "Stone-tract" proper, in which mining for Rubies is carried on as a recognized industry, extends over an area of about 400 square miles, having as its trade-centre the native town of Mogok with the neighbouring townships of Kyat-pyin and Kathe. The "Stone-tract" is mountainous throughout, but between it and the Irrawaddy there is a stretch of low jungle country, or terai, some 30 miles wide, in the flat portion of which, although not included in the "Stone-tract," some mining on a small scale is carried on by the natives.

Mogok itself lies about 100 miles north of Mandalay and 61 miles by road, east of the Irrawaddy. It is situated in the more easterly portion of the "Stone-tract," but it is the chief centre of the mining-industry..

The country may .be described as a dense mass of forest-jungle, rising range after range above the terai, and broken only here and there by alluvial patches at the bottom of the valleys, cultivated for rice. The elevation of Mogok itself is nearly 400 feet above sea level, and the mountain-peaks about it run up to nearly double this.

The Mines may be divided into three classes:—The *Twin-lone* or pit, *Hmyaw-dwin* or hillside working and the *Loo-dwin*, the cavern or cave-mine. The first system is practised in the valley-bottom in the dry weather. The bottoms are perfectly flat, and below an upper stratum of alluvial soil, at a depth varying from 15 to 20 feet, is found the bed of "*byōn*" or Ruby-bearing earth.

Its thickness is generally 4 or 5 feet, though at times it thins out to only a few inches, and it is almost invariably wet and soft. The miner commences operations by driving piles down into the underlying soft earth to form the sides of his pit or "twin." The "twins" are either "9 hole" or "4 hole" twins, according to their size and the consequent number of cross-struts required to support the sides. The piles having been driven as far as possible, the earth inside is dug out and the piles themselves caulked with grass and leaves to keep out water. The struts are put in every 3 feet, and work is carried on between them, a second set of piles being driven as required inside the first, and the work descending in this manner until the byon has been extracted and the "*Akhan*" or substratum unmistakably reached.

For hoisting, the Burman uses the old fashioned balance-crane, known all the world over, but constructs it cleverly out of bamboos, and it certainly answers its purpose most admirably. With these cranes water is baled out in stiff close-meshed baskets about 10 ins. square, and the byon in little round pliable ones some 6 or 8 inches in diameter. Having extracted the byon in this way, it is piled in a heap and, on a convenient day, is either washed on the spot or carried to a neighbouring stream, according to the supply of water available. The apparatus for washing consists merely of a wooden trough about 5 feet long and large enough for a man to stand in. This is set in the ground and a stream of water led through it. The lower end is roughly closed with a few large stones to retard the overflow, and the byon is then fed in and kept alive by being constantly thrown to the head of the trough by a man with a broad tool like a hoe. In this way the water and light stuff are carried away and the washed sand is

taken out from time to time and re-washed in flat fine-meshed baskets.

In some parts and notably in the Kyat-pyin district where the soil is rather stiffer and will stand better, small circular shafts of 2 feet 6 inches to 3 feet diameter, in fact just large enough for a man to work in, are sunk to a depth of 20 to 25 feet to the bed of byon. These shafts are sunk very near together, and the miners drive tunnels from one to another and take out as much of the gem-bearing clay as they dare, but they never resort to either timbering or filling.

With the advent of the wet-season, work in the twin-lones must cease, and that in the "Hmyaw-dwins" or "Hmyaws" commences. The Hmyaws are not mines in the usual sense of the term, but rather cuttings in the hill-sides and vary from the workings of the most insignificant character to vast chasms, though they are all worked on the same principle. A site having been chosen where a bed of byon is believed to exist and where a stream of water can be brought in at the head of the workings, a cut is made and the top soil, generally a marly clay, removed by washing it down with the stream, the stones, of which there are usually a great number, being thrown aside and used as required for building dry retaining walls. The byon in the Hmyaws is generally of a yellowish-brown colour, and very close and stiff, so that it will not only stand vertically, but can be undercut and tunnelled into. The thickness of the stratum is often considerable, as much as 15 or 20 feet, and it is practically a bed of very stiff clay, filled with sand and boulders of rock. It contains also lumps of quartz, grains of felspar, nodules of oxidised iron-pyrites, flakes of mica and graphite, rubies, sapphires, spinels, pieces of tourmaline and other minerals of more or

less value. This bed having been found, a space is cleared, and the water supply so arranged by the clever use of bamboos, that it falls in a spray from a considerable height on to the cleared space or washing floor which is occasionally paved, but not usually. On to this floor and under the falling spray, the stiff byon is thrown as it is cut and finds its way down into the tail-water, by which the clay and a good deal of the lighter minerals are carried away and the washed sand deposited, the process being expedited and assisted by men with hoes stationed at intervals along the channel. At convenient spots deeper pools are formed out of which the sand is lifted in the flat baskets already referred to, washed at the surface of the water, and handed up to a picker who is usually the head-miner or his wife. The rejected sand is thrown in heaps, and it is the privilege of the women and girls of the village to pick these heaps over, and to wash for what they can find in the tail-water after it has left the mine proper.

The third class of mines, the Loodwins or Loos, are cave workings, and are exceedingly interesting, and generally very profitable to the miners. Almost all the mountain-ranges have a base of limestone, covered with the red marly clay or vegetable soil. In the outcrops of the limestone, the entrances to the caves are generally found. The ramifications of these caves are endless, extending in some instances for miles, and whereas at some points they are so contracted that it is only with the utmost difficulty a miner can work his way through, inch by inch, lying at full length and drawing a small basket of byon, tied to one toe behind him, at others they open out into immense vaulted chambers, in which the effect of the light falling on the brilliant white walls and glistening over-arching roof is very striking.

As may be supposed work in these caverns is attended with considerable danger, and it is only attempted by men thoroughly accustomed to it. Frequently the loo takes the form of a vertical shaft, perhaps a couple of hundred feet deep; sometimes it is a deep underground chasm, at the bottom of which subterranean waters may be heard dashing and boiling in the darkness. The air, too, is at times so foul as to make it impossible either to work or to keep lights burning, while on the other hand even in the deepest places it is sometimes fresh and clear, often with a current strong enough to blow a light out. The byon is of a far more sandy nature than in either the twins or hmyaws, and though there are generally fewer stones, they are better as to size and quality.

When the Burma Ruby Mines, Ltd., started work in 1889, great results were expected from the application of European skill and capital to an ancient industry, which had been conducted previously in only a primitive fashion. These expectations were not, however, immediately realized. Several plans of working were tried, one after another, but were not successful. Eventually a really efficient—though extremely simple—plan of working the alluvial deposit in the valley was introduced. Powerful pumps remove the water from the pits, and the top-soil having been discarded, the stratum of Ruby-earth, or byon, is run away in trucks to rotary pans and a pulsator, as in the Diamond mines of Kimberley. This plan was first practised in a small valley near Kyat-pyin, called Tagoungnandaig.

In addition to the Company's own operations, the Ruby "Stone-tract" is very largely mined by the original inhabitants, who pay a royalty to the Company. These miners seem to prosper, and it is satisfactory to note that

the relations between them and the Company's officers are of the most friendly character. Since the Company commenced working, the towns of Mogok and the villages of Kathe and Kyat-pyin, have increased and prospered in a most remarkable manner.

Two or three years ago there was a discovery of Ruby-bearing ground near Mogoung, the old penal settlement in the north of Burma, now reached by a railway. The centre of the new workings is the village of Nanyaseik, 54 miles from Mogoung. In April, 1896, there were about 1000 men at work in the new "Stone-tract," digging on the Twinlone and Loodwin systems, in the midst of a dense jungle. The conditions under which the Rubies occur are described by Dr. Warth as similar to those of Mogok; but the stones are said to be mostly flat, and to exhibit a peculiar frosted appearance. Rubies have also been reported from other localities near Mogoung.

In addition to the workings near Mogok and Mogoung, there are also Ruby mines—which have long been worked on a small scale—at Sagyin, about 15 miles to the north of Mandalay, where a beautiful white marble is also found and worked especially for sacred images.

CHAPTER III.

THE AUTHOR'S CONNECTION WITH THE RUBY MINES OF BURMA.

AS my connection with the Ruby Mines of Upper Burma has been a subject of public curiosity, and not unfrequently of groundless speculation, I may take this opportunity to offer a brief sketch, shewing the origin and nature of my relations with these mines.

Most persons interested in precious stones have been fascinated by the glamour of the Oriental Ruby. Many years ago, during King Theebaw's reign, my eldest son, the late Harry Edwin Streeter, who lost his life while pearling with my fleet in the Western Australian waters, (an industry now carried on by my son G. Skelton Streeter), expressed a strong desire to visit the Burmese Ruby Mines. Knowing, however, how jealously these mines were guarded from all Europeans, I would not for a moment countenance so hazardous an expedition. But when Upper Burma some years afterwards became part of the British Empire, the case was entirely altered, and I felt that the time had come when the resources of the country—including the mysterious mines which for ages had practically supplied the world with Rubies—would be thrown open to commercial enterprise.

Whilst in Paris one morning in December, 1885, I was taking breakfast in the saloon of the Grand Hotel, when two gentlemen sitting at the same table happened to be talking about the Ruby mines of Burma. They referred to a lease, which was to have been granted by King Theebaw to certain Frenchmen, conceding the right of working the mines, but which, in consequence of the British occupation of the country, had never been signed. Naturally feeling deep interest in such a subject, I joined in the conversation, with the result that I was afterwards introduced to the parties in treaty for the concession. It appeared that Messrs. Bouveillein & Co. had petitioned the king to grant them the sole right of mining for Rubies, in consideration of an annual payment of three lakhs of rupees. They further agreed to pay four years' rent in advance, and to make a present of one lakh to the king. The Burmese Ambassadors in Paris had granted a provisional concession, and this I ultimately obtained, together with all the documents relating thereto, but being of no value they were returned to Paris.

On my return to England, I immediately placed myself in communication with the India Office, with the view of obtaining a concession of the Ruby mines in Upper Burma. On December 24, I was officially informed by Lord Harris that it was for the Government of India to decide upon my application; and it was suggested, in the same letter, that I should communicate directly with the Secretary of the Foreign Department at Calcutta. After some further correspondence, it was agreed that I should send an accredited agent to the Indian Government with the view of personally effecting the negociations.

Associating myself with three friends, we formed a

syndicate to carry out our enterprise, and engaged the services of Captain Aubrey Patton (now Major Patton-Bethune) as our representative. In January, 1886, Captain Patton started for India on our behalf, furnished with a letter of introduction from Lord Harris to Lord Dufferin, who was then Viceroy. On arriving at Rangoon, our agent found that Messrs. Gillanders, Arbuthnot & Co., of Calcutta and Rangoon, in conjunction with an eminent jewel broker of London, had already made an offer to the Government for a lease of the Ruby mines at the annual rent of two lakhs of rupees. This offer the Government was disposed to accept; but our representative, who had full discretionary powers, made an offer of three lakhs, whereupon the Viceroy telegraphed home for enquiry as to the *bonâ fides* of my syndicate. The India Office sent in reply a favourable telegram; but notwithstanding this assurance, the Indian Government, after some further negotiations, decided to invite public tenders.

Having reason to believe that several competitors might appear, we deemed it expedient to increase our offer, and finally our tender was made for four lakhs of rupees. On April 15, 1886, a telegram from the Foreign Secretary in India informed our representative that his tender, on our behalf, had been conditionally accepted by the Governor in Council.

It was decided, in July, 1886, to despatch a military expedition to the mines, and the Government of India wrote to our agent, suggesting that a representative of the syndicate should accompany the force. Accordingly, my son, Mr. George Skelton Streeter, with Colonel Charles Bill, M.P., and Mr. Reginald Beech, the three members of my syndicate, started at once.

They arrived in India in August; and, after seeing Captain Patton at Simla, proceeded to Rangoon, and thence to Mandalay, where they were kindly received by Sir Charles Bernard, the Chief Commissioner, with whom they had a long conferance on the important subject of native rights at the Ruby mines.

Delayed by heavy rains and by sickness among the troops, the Ruby mines column did not make a start until November. In due course they reached Kyannyat, a township on the left bank of the Irrawaddy, which it was intended to use as a base. Here news reached the party that organised resistance was being prepared by the hill-tribes in the mining districts. The dacoits were also giving much trouble. As the expedition advanced and approached the mountain pass which leads to Mogok, the principal seat of the Ruby mining, determined resistance was encountered and skirmishes ensued. One of the Ghoorkhas, who brought to my son the head of a dacoit, seemed much surprised that the sight of this trophy, the relic of an enemy just slain, should afford him no pleasure!

By this time the troops had reached an altitude of some 6,000 feet above sea level. The thermometer during the night registered six degrees below freezing point, and as no provision had been made for so low a temperature, great inconvenience and even hardship was felt. The gorge in the mountains had been carefully stockaded by the enemy, and the curiously shaped rocks were skilfully turned into positions of defence; but as the troops approached, these posts were abandoned one after another, and progress was effected without much difficulty.

Mogok was ultimately reached on December 27th; and, to the surprise of the expedition, was found to be

deserted. The panthays were sent out to call in the people from their hiding places in the jungle and gradually the villagers returned, but a long time elapsed before any of the headmen appeared.

While the expedition was at Mogok, great difficulties were experienced and much privation endured; but at the same time a good deal of information, previously unknown, respecting the mines and the system of working them, was gradually collected. It was discovered that the lessees under King Theebaw were not licensed to work the mines themselves, but paid 2½ lakhs of rupees per annum, for the privilege of collecting taxes and dues. The lessees financed the affairs of the poor miners, lending them money, for which they extorted exorbitant interest, and otherwise using their great power oppressively. In February, 1887, Mr. F. Atlay, son of the late Bishop of Hereford, arrived at the mines, with an interpreter, to act as our representative after my son had left the district, and he subsequently became manager of the mines for us. He stills holds a position there for the present Company.

At the request of Mr. Carter, the Deputy-Commissioner, my son acted as valuer for the Government, of all stones brought in by the natives—a task of great delicacy, difficulty and, at this early period of our occupancy, even of danger. At a later period he was present with Mr. (afterwards Sir Charles) Crostwaithe, the Chief Commissioner, at an interview with the principal headmen of the district, when the regulations for the management of the mines were discussed, and the rights of the native workers defined and protected. In April, 1887, he signed a provisional agreement with the Chief Commissioner for a lease of the mines for 5½ years; and, pending the confirmation

of the agreement by the Secretary of State for India he obtained the Chief Commissioner's sanction to hold an ordinary mining license. He likewise obtained the monopoly of purchasing stones in the Ruby tract on payment of an *ad valorem* duty of 30 per cent. to the Indian Government. Shortly afterwards he returned to Mandalay, *en route* to England, leaving Mr. Atlay at Mogok to carry on mining work at the mines and to purchase Rubies on behalf of our syndicate. Mr. Atlay, thus left to himself, soon found that he was exposed to much treachery and that he was powerless to prevent smuggling by the miners.

Meanwhile difficulties had arisen at home as to granting the concession. Notwithstanding the large sum of money which we had expended, since we had been the accepted concessionaires of the Government of India, the Secretary of State in Council declined to ratify the provisional agreement, until he had obtained definite information as to the value of the mines and as to the protection of native rights. With the view of ascertaining the value, it was decided to send from England a Mining Geologist to report upon the mines and their probable yield. Accordingly Mr. C. Barrington Brown was commissioned to proceed, to Burma, and he reached the Ruby mines on January 10, 1888.

Those who were acquainted with the working of the machinery behind the scenes were not altogether without an explanation of the remarkable change of attitude towards our Syndicate. An enterprise of so romantic a nature as the exploration of the famous Ruby mines of Burma could not fail to attract much public attention; and both in Parliament and in the Press, at home and in India,

frequent reference was made to our operations. After Mr. Durand, the Foreign Secretary of the India Government, had informed Captain Patton, on April 15, 1887, that the Governor in Council had conditionally accepted our tender, we were led to conclude, not unnaturally, that the negotiations were practically settled in our favour; and most people regarded us as undoubtedly the accepted concessionaires. But it was not long before the jealousy of disappointed competitors began to find public expression. Certain members of the House of Commons were prompted by them to ask questions framed in such a way as to prejudice our interests. Nor were political influences wanting in the opposition to our concession. Great injustice was also done to me, and still more to the Indian officials, by the unfounded criticisms and unfair suggestions of a portion of the London press. From time to time telegrams from Rangoon, extremely prejudicial to our interests, sent over by the *Times* correspondent, appeared in that paper; but it was not without significance that the Rangoon correspondent of *The Times* was the legal adviser of Messrs. Gillanders, Arbuthnot and Company, one of our rivals for the concession. If any undue influence was at work during the negotiations, as insinuated by the Press, *it was most assuredly not on our side*, and the idea, as suggested in certain papers, of our bribing some of the Indian officials was *absolutely unfounded*. I can say that in not one instance did I give or offer a bribe during the whole time, extending nearly over three years, while the Government of India and Parliament at home, were slowly coming to a decision.

Considerable trouble was occasioned during the negotiations by the action of a certain Mr. Moritz Unger, who ultimately represented himself as acting for Messrs. Rothschild, and whose supposed grievances as an applicant

for the concession were laid before the House of Commons. He made no application until March, 1886, and then "presented himself to the Chief Commissioner of Burma as the agent of a Syndicate in Paris, and as the mouthpiece of certain unnamed European capitalists." These words are quoted from a telegram from the Viceroy to Lord Cross, dated June 5, 1887, and this same telegram, referring to the conditional agreement with our Syndicate, concluded with the noteworthy expression: "We see no just grounds for cancelling this agreement." But strangely enough, Lord Cross, the Secretary of State, thereupon telegraphed to the Viceroy: "Make no arrangement with anyone without sanction from home." It is difficult to reconcile such instructions from Lord Cross with the statement in Lord Harris's letter to me that the concession was "a matter for the Government of India to decide!"

It was naturally with much surprise and disappointment that we found the India Office suddenly adopting a new policy, and practically cancelling the action of the Viceroy, Lord Dufferin. The fact seemed to be ignored that we had obtained the conditional concession simply because we had made the highest tender. The suspicion of a "job" having been perpetrated was utterly groundless. After our tender had been accepted in India, we had incurred extremely heavy financial responsibilities, whilst our representatives, who had gone as pioneers to the mines, went under conditions of great difficulty and danger, to the injury of their health, and at the imminent peril of their lives. Yet all our claims, legal and moral, were suddenly ignored by the Government at home!

It is pleasing to record that on the official publication of the correspondence in the "Blue Books," public

opinion veered round in our favour, and *The Times* of August 17th, 1887, and most other papers, published articles upon the unfair treatment which we had received from the English Government, whilst speeches favourable to our interests were delivered in the House of Commons.

The lease from the Government was signed on February 22, 1889; and shortly afterwards "The Burma Ruby Mines, Limited,"—a Company to which the lease had, by permission, been assigned,—was brought out by Messrs. N. M. Rothschild and Sons. For an account of the issue, the reader may be referred to *The Times*, of 27 February, 1889.

With the formation of this Company, the management of affairs passed out of my hands, and my direct connection with the Ruby Mines of Burma ceased. I am consequently in no way responsible for the disappointing results which have hitherto attended the Company's operations. At the same time I do not hesitate to reiterate my belief that the Burma Ruby Mines, if skilfully directed and well managed, will yet be a highly remunerative enterprise. But in order to secure success it is of first importance that the management should be in the hands of those who have had experience in the special manipulation and cutting of gem-stones. Not only should the Company prosecute its own mining operations with vigour, but it should have at the mines and also in Mandalay, experts empowered to purchase rough stones from the native miners and dealers; and I feel assured that if these were purchased with discretion, and judiciously cut in this country, a new and important source of profit would be opened up, sufficient to place the Company at once on a firm dividend-paying basis.

The more important figures of the last five years working, which are given below, will show the position and progress of the Company.

	Loads washed.	Gross cost per load (exclusive of rent).		Expenditure (exclusive of rent).	Rent paid to Government.	Royalties received from Natives.	Balance on Ruby Trading Account.
		s.	d.	£	£	£	£
1893-4	20,089	29	2¾	29,359	12,708	20,585	4,535
1894-5	61,080	8	10	26,986	11,276	21,395	16,744
1895-6	148,740	3	9¼	28,390	11,250	28,277	27,204
1896-7	366,739	3	1	*56,718	18,437	22,534	43,529
1897-8	823,703	1	2¾	50,576	20,815	9,976	52,146

* Includes £23,824 depreciation of Machinery, &c.

It is satisfactory to note that, with improved methods of working, a large increase in the yield of Rubies has recently been obtained. Moreover, several improvements are in course of development, notably the importation of electrical machinery, which will tend to render the working more efficient and economical. Thus, the water of the Mogok river is to be utilized for providing electrical power to pump the mines, and also to work generally all the machinery; and it has been said that, after all, pumping is the real crux of Ruby mining.

The difficult nature of the country may be imagined when it is stated that it took seventeen days for the electrical plant to traverse seventeen miles.

CHAPTER IV.

THE SAPPHIRE.

BEAUTIFUL as this gem unquestionably is, it probably derives no little enhancement of interest from the exalted character of the comparison with which it is associated in the Sacred Volume. The Prophet of the great captivity compares "the appearance of the likeness of a throne" in the firmament above the cherubim to a "Sapphire Stone;" and generally it may be affirmed that around no Precious Stone can be grouped more imposing allegories and properties than have been associated with the Sapphire.

Up to quite modern times the Sapphire was regarded as a charm or a medicine, and very extraordinary powers were attributed to it. It was dedicated by the Greeks to Apollo, because, when consulting his oracle, they thought that the possession of this gem, from its heavenly nature, would secure them an early and favourable answer.

Among ancient writers, Solinus refers to several characteristics of our Sapphire, especially its blue colour and its extreme hardness. The Sapphire is, in fact, only a variety of Corundum, or crystallized alumina; and much, therefore, that was said under the head of Ruby, will apply to the Sapphire.

The characteristic colour of the Sapphire is a clear blue, like that of the "corn-flower," and the more velvety its appearance, the greater its value. Some Sapphires retain their colour by gas light, while others become dark, and

some assume a reddish or purple colour, and occasionally have the hue of the Amethyst; the latter being very rare are very valuable, and are known as "Oriental Amethyst."

While the typical colour of Sapphire is blue, it should be explained that the term Sapphire is extended by mineralogists and jewellers to Corundums of other colours. Thus, we may have *green* Sapphires, a variety which was at one time regarded as amongst the rarest of precious stones; other Sapphires may present various shades of *yellow* and *grey*, whilst others again may be entirely destitute of colour; these pure *white* Sapphires being sometimes mistaken, when skilfully cut, for Diamonds. In fact, transparent Corundums fit for jewellery may be ranged in two groups; those of red or reddish colours being called *Ruby*, and those of any other tint passing under the designation of *Sapphire*. The colours and shades of Sapphire are very numerous.

Although Sapphires enjoy a fairly wide geographical distribution, those which present the standard colour, or the true corn-flower blue, are by no means common. The principal Sapphire-yielding localities now worked are in Siam, Burma, Cashmere, Ceylon, Australia and the United States. Each of these localities will be separately described in the course of this chapter. The Sapphires of Siam are the finest at present in the market; those of Burma are too dark or blackish; Cashmere has yielded some very fine stones, but others are only greyish-blue; while those of Ceylon are usually too pale in colour to be of great value, though occasionally very fine Sapphires are found there. Large deposits of Sapphire occur in Montana, but the stones are mostly of green and other fancy tints, though sometimes peacock-blue. The Sapphires of Australia are generally too dark and full of iron, and not at present of much commercial significance.

The most important Sapphires known in Europe are two magnificent stones which were exhibited in the London Exhibition of 1862, and in the Paris Exhibiticn of 1867. The larger is a stone of a somewhat oval form, of a dark, slightly inky, colour, free from defects. It weighs about 252 carats, and was cut from the rough by Mr. Loop in 1840. The other, though a smaller, is a richer coloured stone. It was brought to this country from India (Indian cut) in the year 1856. In its original form it was a badly-shaped stone, weighing 225 carats, with a large yellow flaw at the back, which marred the stone by casting a green reflection into it. It was placed in the hands of the late Mr. J. N. Forster, successor to Loop, who re-cut it, removed the defects, and made it a splendid gem of 165 carats. This, which is by far the finest Sapphire of the size in Europe, was sold in Paris, and is estimated to be worth from £7,000 to £8,000.

In the Jardin des Plantes, in Paris, is a Sapphire weighing 133 1/16 carats, and without spot or fault. This stone is said to have been originally found in Bengal by a poor man; it subsequently came into the possession of the House of Raspoli, in Rome, who, in their turn, left it to a German prince, who sold it to the French jewel merchant, Perret, for £6,800.

In the late Hope Collection there was a large Sapphire of a rich colour, which retained its beauty as well by candle as by daylight. Another, in the Orleans Collection, was called in Madame de Genli's tale "Le Saphir Merveilleux."

Notwithstanding the extreme hardness of the Sapphire, there are some beautifully engraved specimens of this gem still in existence. In the Cabinet of Strozzi, in Rome, is a Sapphire, a masterpiece of art, with the profile of Hercules

engraven on it, by Cnetus. A very remarkable and famous Sapphire, belonging to the Marchese Rinuccini, weighing fifty-three carats, has a representation of a hunting scene engraven upon it, with the inscription "Constantius Aug." Among a number of old family jewels there was found by the author a few years' ago, a Sapphire beautifully engraved with the crest and arms of Cardinal Wolsey.

The value of Sapphires is very much determined by special circumstances; colour, purity, and size must be taken into consideration when fixing the sum to be paid.

Those imperfections which appear at times in the Sapphire, and which lessen its value, are clouds, milky half-opaque spots, white glassy stripes, rents, knots, a congregating of colours at one spot, and silky-looking flakes on the table of the stone. Whenever a Sapphire obtains a purple tint it is an unfailing indication of the presence of the silky defect somewhere in the stone. If a greenish tint be observable, then a "milky flaw" will probably be detected on careful examination.

SIAM SAPPHIRES.

Some of the finest Sapphires are obtained at the present day from certain mines in Siam. They occur principally in the Province of Battambong, where they have been systematically worked only within the last few years; and they are also found, associated with Rubies, in Chantaboon and Krat. Many of the stones yielded by these mines present an unrivalled velvety blue colour, and it fortunately happens that the Sapphires of over one carat in weight are better in colour and in general quality than smaller stones. Although the mines have only been regularly worked for about thirty years, the occurrence of Sapphires there was probably known to the natives long previously.

The most productive Sapphire mines of Siam are those of Pailin, about 50 miles from Battambong. The mining district occupies an area of about six miles by two, and comprises a number of villages, of which Bo Yaka and Bo Din Nia are the chief.

The mines consist of rude excavations on the sides of the mountain and in the valley. These excavations usually take the form of pits, from four to six feet square. The actual stratum which contains the Sapphires is a clay, with gravel, about 20 inches thick, and occurring at variable depths up to about 20 feet below the surface. The miners work in gangs of two or three in each pit, and raise the Sapphire-earth in baskets, by means of ropes made with creepers. The clay is washed, and the gems are picked out of the residuum by hand. The miners are chiefly Shans, who employ Laos as labourers.

Prof. H. Louis, in describing the Sapphire and Ruby mines of Moung Klung, a district between the two provinces of Chantaboon and Krat, expresses his opinion that the gem-stones have been derived from the disintegration of the trap rocks, which enter largely into the constitution of the neighbouring hill-ranges.

The principal gem-bearing country of Siam, so far as at present known, covers a very large area, with the seaport of Chantaboon as a trade centre. It appears that the gem mines in the province of Chantaboon have been worked much longer than those of Battambong.

The Sapphire mines of Siam have been described recently by Mr. H. Warington Smyth, who resided in Siam for several years as a Government official directing the mining industry of the country. He visited not only the gem-mines of Battambong, Chantaboon and Krat, but

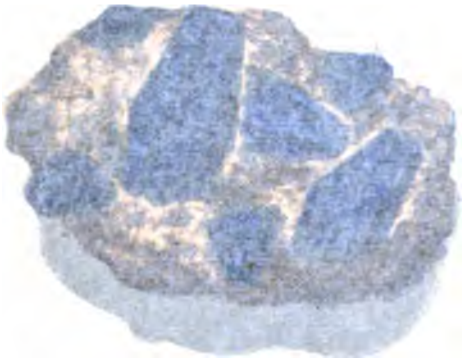
also those of Chiong Kawng, in the Lao States, near Burma. These Sapphire-deposits were discovered by scme Burmese Shan diggers in 1890. The gem-gravel is here from 5 to 18 inches thick, and is associated with basalt, from which the Sapphires were no doubt derived. Unfortunately the Sapphires were mostly either too dark or too pale in colour, and it is believed that the workings are now nearly deserted.

BURMA SAPPHIRES.

It is well known that Sapphires are found, associated with Rubies, in Upper Burma, but they are not very common and are usually of a dark colour. When Mr. Atlay worked the Ruby mines for the author, before the formation of the Company, he frequently obtained Sapphires in association with the Rubies. Mr. G. S. Streeter on one occasion visited a famous mine which had yielded Sapphires, but found it in a very dangerous condition, the surrounding rock at the top being so rotten that he had to be secured by means of ropes.

Although the Burmese Sapphires are not generally of very fine quality, they occur of larger size than the associated Rubies, and occasionally present exceptional dimensions. About 20 years ago, a Sapphire of 820 carats was found at Pyoung Goung (Bernardmyo), and was exhibited for some time as a curiosity at Kyat-Pyin. It was purchased by Gna Myo, then So Thugyi of Kyat-Pyin, for 4,000 rupees, and was accepted by King Theebaw, in lieu of a payment of monopoly rent of 10,000 rupees.

A Sapphire weighing nearly 400 carats, found at Bawbadan, was purchased by Oo-dwa-gyi, the Woon of the Ruby tract, for 6,000 rupees, and after passing into Theebaw's possession, was sold to Moung Ba, a dealer in



SAPPHIRE in the Matrix

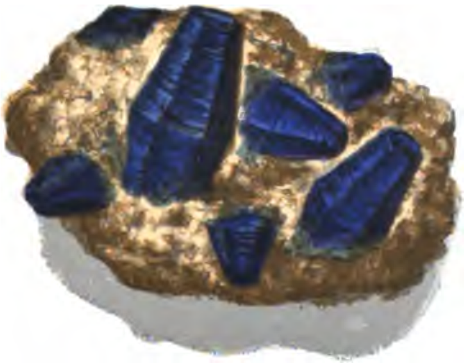
[illegible] range of Chiong Kawng, in the Lao States, near Siam. These Sapphire deposits were discovered by some [illegible] Shan diggers in [illegible]. The gem gravel is here from [illegible] to [illegible] inches thick, and is associated with [illegible], from which the Sapphires were no doubt derived. Unfortunately the Sapphires were mostly either too dark or too pale in colour, and it is believed that the workings are now nearly deserted.

BURMA SAPPHIRES

It is well known that Sapphires are found, associated with Rubies, in Upper Burma, but they are not very [illegible] and mostly of a dark colour. When Mr. [illegible] the Ruby mines for the author, before the [illegible] Company, he frequently obtained [illegible] with the Rubies. Mr C. S. Streeter [illegible] visited a famous mine which had [illegible] found it in a very dangerous condition, the [illegible] of the top being so rotten that he had to [illegible] by means of ropes.

Although the Burmese Sapphires are not generally of [illegible] fine quality, they occur of larger size than the associated Rubies, and occasionally present exceptional dimensions. About [illegible] years ago, a Sapphire of [illegible] carats was found at Pyaung Gaung (Bernardmyo), and was exhibited for some time as a curiosity at Kyat-Pyin. It was purchased by Gna Myo, then Sa Thuggyi of Kyat Pyin, [illegible] rupees and was accepted by King Thebaw in [illegible] of a payment of [illegible] tax of 10,000 rupees.

A Sapphire weighing nearly [illegible] carats, found [illegible] was purchased by [illegible]-dwa-gyi, the Woon of [illegible] Kyat, for [illegible] rupees, and after passing into [illegible] possession, was sold to Maung Ba, a dealer in



SAPPHIRE in the Matrix.

Mandalay, for 20,000 rupees. It was then cut similar to a brilliant, and reduced in weight to 120 carats, and was ultimately disposed of in Calcutta.

The finest Sapphire ever seen in Burma was dug up in King Mindoon Min's reign, at Wetloo village, between Kyat-Pyin and Khabine. In the rough it weighed 253 carats, and, when Indian cut, 161 carats. It was purchased for the king for 7,000 rupees, and passed ultimately into the hands of Theebaw.

CASHMERE SAPPHIRES.

A remarkable discovery of Sapphires was made about 20 years ago, in the Chinab valley of the Himalayas of Cashmere (Kashmir). According to the Rev. A. W. Heyde, a Moravian missionary, who was for many years resident in Lahul, they were first discovered by a *shikari* about the year 1880. It appears that a landslip had laid bare the rock, and exposed the Sapphires. The precise locality was long kept secret, but from information received by the author there is no doubt that it is situated between the two villages of Soonjam and Machel, in the neighbourhood of Padam, or Padar. The exact spot seems to be difficult of access, and to be situated at a great elevation, near the limit of perpetual snow. The surrounding rocks consist of gneiss, with intercalated crystalline limestones, dipping to the east at an angle of about 40 degrees. The gneiss contains Garnets, and is intersected by veins of granite in which the Corundum occurs, associated with much Tourmaline. The Sapphires were found loose among the granite detritus, in the side of a valley, high up on the mountains.

By far the greater number of the Sapphires were fragments of crystals more or less rolled. A description of

the crystals was published, soon after the discovery, by Mr. F. R. Mallet, in the Records of the Geological Survey of India. He pointed out that the crystals were mostly double hexagonal pyramids, often irregular in shape, much flattened, and deeply furrowed with horizontal striations. A large number were milky, and of pale bluish-grey colour, while many were rendered imperfect by "silkiness." The Sapphires were in many cases penetrated by dark brown and green Tourmaline. Specimens preserved in the author's collection of rough Precious Stones exhibit these characters.

Some of the Cashmere Sapphires are of very fine colour, but many are depreciated in value by a slight opacity, and are streaky in a strong light.

The discovery of Sapphires in Cashmere is said to have taken place in this wise. Near the spot where the stones are found lived a "Bhôt Lamba," or monk, who first observed a pale blue vein in the rock. He broke off pieces and exchanged them with traders for sugar and tobacco, carefully concealing from whence he obtained his treasures. Subsequently he disposed of a quantity to some Lahul men, who took them to Simla. One piece said to have been about a foot long and three or four inches in circumference, he was persuaded to give to one of his brotherhood, in order to have a "Shib" or idol made of it. A lapidary who was to make it into an idol, finding it extremely hard, came to the conclusion it must be of value; and showed it to an official, who decided to send it to the Maharajah of Cashmere, at Jummoo. On enquiry being made, a messenger was despatched to bring the Lamba who found the stone, and he was forced to disclose the locality where he obtained it. The Maharajah immediately sent a responsible official and a strong guard to protect the place, until the actual value of the discovery should be known.

Sapphires are also found by the Lacha Pass. A native loaded 100 goats with them, thinking they were lapis-lazuli, and came to Simla through Kulu, a journey of about 10 days. Arriving at Simla, he tried to dispose of them, but their value not being recognised, he could not even obtain a rupee a tolla for them, which he would gladly have taken, being in a state of semi-starvation. He then proceeded to Delhi, where the jewellers, knowing them to be Sapphires, gave him their value.

In 1895, Dr. Warth, of the Geological Survey of India, discovered a large vein of blue Corundum, associated with cyanite, near Balarampur, in Bengal.

CEYLON SAPPHIRES.

In Ceylon the Sapphires are usually found with other gems, either in the old river beds or in a bed of gravel, which occurs at a depth of from 6 to 20 feet beneath the surface. The villagers have sunk numerous pits in this gravel, and work in gangs of six or eight. After stripping off the surface soil, they probe the ground with an iron rod, about six feet long, in order to ascertain the position of the gem-gravel. When found, the gravel is dug into, and tunnelled round the bottom, as far as the firmness of the bed permits. The gravel dug out is washed in wicker baskets and the stones picked out by hand.

Whilst the greater part of the Corundum found in these gravels is too coarse for use as gem-stones, there are found in the old river gravels considerable quantities of true Sapphires, more or less transparent, but often of pale colour. Some of the Sapphires are white, and many yellow, while others are parti-coloured, the blue being confined in many cases to one part only of the crystal. With the Sapphires are found rolled crystals of Zircon, Tourmaline, Chrysoberyl, Spinel, and Quartz.

According to the *Ceylon Observer*, of May 4, 1889' there had been recently found "a monster blue Sapphire, the shape of a piece of jaggery, weighing down in the scales 17 rupees."

MONTANA SAPPHIRES.

Although it is only recently that the importance of the Sapphire mines of Montana has been recognized, the existence of the gem-stones at this locality has long been known. In working the gold-bearing drifts of the Missouri river, near Helena, Montana, there were found numbers of curiously-shaped stones which attracted the attention of the gold-mining pioneers; but after casual enquiry it was stated by jewellers that they were nothing more than quartz, and consequently of no value. The restless gold-seeker, did not therefore trouble to collect them, and after the failure of the supply of water, he moved on to what he thought more promising fields, and the "curious crystals" were forgotten. A few of them, however, were carried away by the wandering miners, and ultimately found their way to the jewellers of New York, where they were recognized as Sapphires, and the fine gem-stones, after cutting, found a sale at good prices.

It is stated by Mr. George B. Foote, one of the pioneers of Helena, that the first discovery of these gems was made at Eldorado Bar, in December, 1865. The earliest scientific reference to the stones was from the pen of the late Dr. J. Lawrence Smith, the eminent mineralogist, who in a paper contributed to the *American Journal of Science* for September, 1873, called attention to the existence of the Sapphire in North Carolina and Montana Territory.

The Montana Sapphires usually present the form of hexagonal tabular crystals, more or less rolled, many being

fractured and splintered, and differing somewhat from the ordinary Sapphire crystals of other well-known localities, where the prevailing form is that of the double hexagonal pyramid. The Montana stones present almost all colours and shades, including greens, violets, yellows, blues and pinks. The variety of delicate tints is extraordinary; and, when well cut, the brilliancy of the stones is remarkable, being inferior only to that of Diamonds. Many of the stones have triangular markings, somewhat similar to those on the Diamonds of South Africa. It is notable that some of the Sapphires of green and light blue shades become purple or red by artificial light. The lapidaries who have cut them pronounce the stones to be unusually tough, and their extreme hardness will enable them to sustain wear without loss of lustre. Their brilliancy and beauty should bring them into favour with all lovers of true gems. The different forms of crystal, and their colours, are represented in the accompanying plate.

The author, on visiting the property, mined several thousand carats of gem-stones. Among them he found a very curious crystal of Sapphire with a red stone embedded in the centre. (see plate). The Sapphires are most plentiful at or near the bed-rock of the old river-terraces or bars, many of which are from 100 feet to 200 feet above the present channel. These dry river-terraces are for the most part covered with alluvial deposits of sand and gravel, varying from a few inches to 20 feet in thickness. All this alluvial detritus carries gold in paying quantity, and a simple hydraulic apparatus is all that is required to mine rapidly and cheaply for both Sapphires and gold.

The rocks in the vicinity of the mines are limestone, quartzite, and dark argillaceous slate, probably of Lower Silurian age. The bed-rock of the bars or river-terraces,

is a dark, friable slate, broken through by eruptive dykes, in some places hornblendic and dioritic, in other places quartzose. At one point near the river, the dykes appear to be trachytic and porphyritic, with amygdules and dark mica. At other points the dykes are more like grey lava. Prof. H. A. Miers, has described one of the dykes as a mica-augite-andesite. The dykes contain Sapphires, Garnets, and other minerals, in well-defined crystals and in rounded masses. It is evident that the denudation of these dykes has set free the Sapphires, and other stones, now found loose in the gravels with the gold.

Sapphires have recently been discovered at Yogo Gulch, on the Judith River, and elsewhere near Utica, in Montana. Some of the Yugo Gulch stones are of deep colours, including cornflower and peacock blue. Their mode of occurrence has been described by Mr. Kunz, whilst the character of the crystals has been studied by Mr. Pratt. The Sapphires have been traced to certain igneous dykes composed of a rock recognized by Mr. Pirsson as a dark basic lamprophyre, and he believes that the Sapphires were actually formed in this rock as a true matrix.

AUSTRALIAN SAPPHIRES.

The Sapphire is found in many parts of Australia, but the stones are usually of too dark a colour to be of value for jewellery. In the wide-spread auriferous drifts of the goldfields of Victoria, the Sapphire is by no means an uncommon mineral. Probably it has here been derived from the basaltic rocks which, by their disintegration have yielded most of the constituents of the gold-bearing gravels.

The Sapphire is also widely distributed in New South Wales, especially in the New England district, where it

occurs in the tin-drifts with other gems in the form of small rolled pebbles, associated in many cases with alluvial gold. The tin deposits south of Emmaville, and between that town and the Severn, have been specially rich in Sapphires. They have also been found in the drift near Crookwell; and at Tumberumba, Berrima, Mittagong and Kiandra. The Berrima Sapphires present a considerable variety of colour, including brown, bronze and honey-yellow; some of the crystals are of large size, and the bronze-coloured varieties are notable for their high density, which may rise to 4·4, or even higher. In the opinion of the Rev. J. Milne Curran, who has paid much attention to the subject, the matrix of the New South Wales Sapphire is basalt; and by the disintegration of this rock the stones are set free, and so find their way into the alluvia and drifts.

Queensland likewise yields Sapphires, especially near Withersfield, more than 200 miles from Rockhampton. Here they occur, with zircons and other gem stones, in a drift containing pebbles and boulders of quartz, resting on a decomposed surface of gneiss. Some of the Sapphires are of Royal blue colour, but most are dark blue; a few are green, while others exhibit alternations of blue and green laminæ. Unfortunately most of the Australian Sapphires cut too black, though now and then a small piece of really fine colour may be taken off the edge of a large stone.

In 1890, it was reported that a fine Sapphire had been found by Mr. T. Bakhop, of Lower Junction, Tasmania, on one of his properties in the north-eastern part of the island.

CANADIAN CORUNDUM.

Important deposits of Corundum have lately been discovered in the province of Ontario. It is true that they

have as yet yielded only very few stones which are f enough to be cut for purposes of jewellery, but it is means improbable that when a lower depth is reach may furnish Sapphires of better quality.

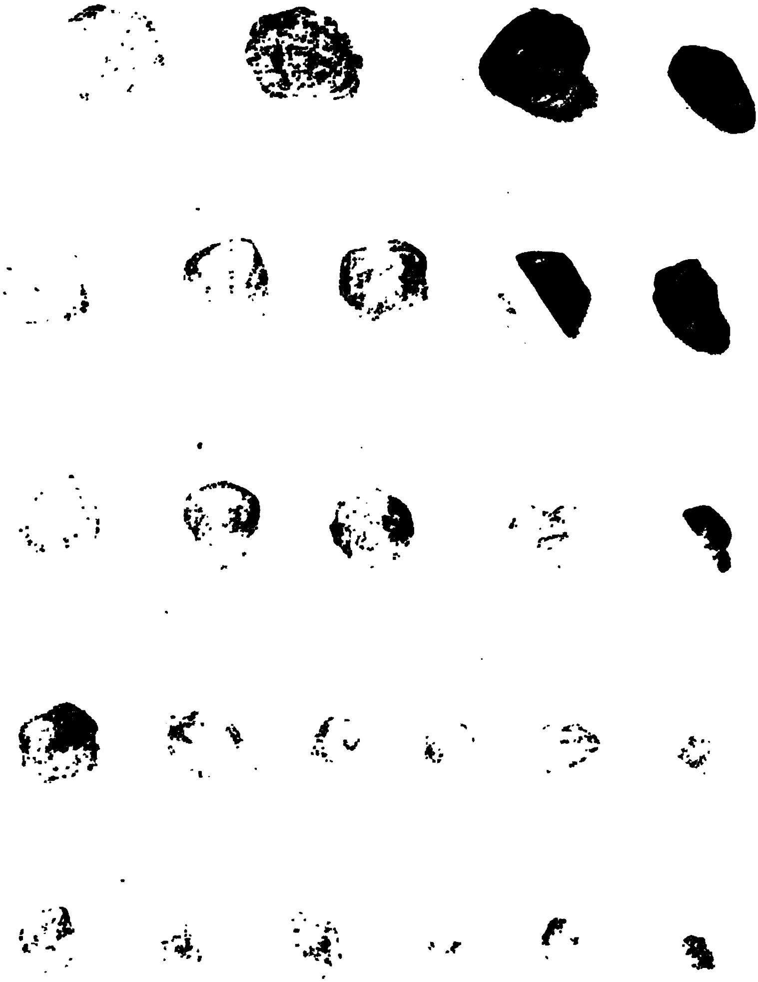
In 1896, Mr. W. F. Ferrier, of the Geological Survey of Canada, called attention to the occurrence of Corundum in the township of Carlow, in the northern parts of Hasting's County. The mineral had previously been detected, but was generally regarded as apatite or as pyroxene. Subsequent investigation by Mr. Barlow and others proved the existence of a great "Corundum belt," stretching for a length of about 30 miles, with an average width of 2 miles. The Corundum is usually found in crystals and irregular masses, sometimes of large size, embedded in dykes of a felspathic rock, like pegmatite, running through the Laurentian gneiss; and it has also been discovered in nepheline-syenite, associated with the gneissose series.

Most of the Canadian Corundum is of brownish or greyish colour; but occasionally it is blue, and in the township of Brudenell it presents varieties of greenish, yellow and even rose-red tints, though the last is extremely rare. The most Sapphire-like varieties hitherto found have been obtained from the township of Methuen, in Peterborough County.

Some of the Canadian Corundum which I have had cut has yielded small cabochon Sapphires of fair colour.

SAPPHIRE.

Composition	Alumina.
Specific Gravity	4, or thereabouts.
Hardness	9.
System of Crystallization ...	Hexagonal.
Form...	Double six-sided pyramids, or prisms; usually as rolled crystals.



ROUGH MONTANA SAPPHIRES AND [illegible]

have [illegible] yielded only very few stones which are [illegible] [illegible] cut for purposes of jewellery, but it is by no means improbable that when a lower depth is reached it may furnish [illegible] of better quality.

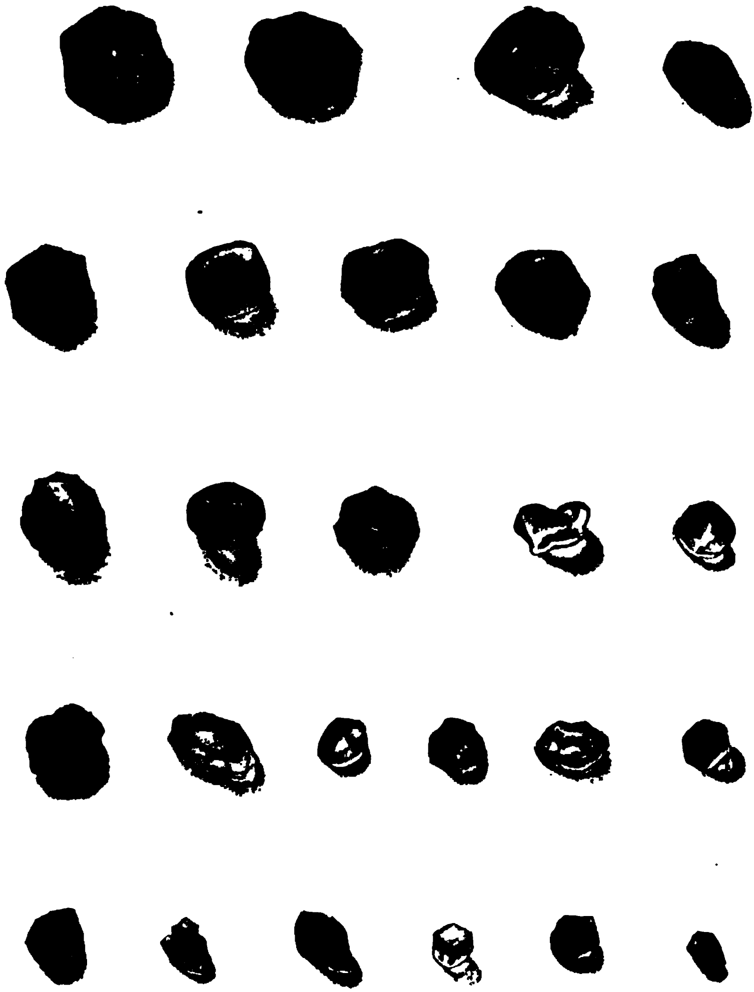
In 18[illegible], Mr. W. F. Ferrier of the Geological Survey of Canada, called attention to the occurrence of Corundum in the township of Carlow, in the northern parts of Hastings County. The mineral had previously been detected, but was generally regarded as apatite or as pyroxene. Subsequent investigation by Mr. Barlow and others proved the existence of a great "Corundum belt," stretching for [illegible] of about [illegible] miles, with an average width of [illegible] miles. [illegible] Corundum is usually found in crystals and irregular [illegible], sometimes of large size, embedded in dykes of a [illegible] rock [illegible] pegmatite, running through the [illegible], and it has also been discovered [illegible], associated with the gneissose series.

[illegible] the Canadian Corundum is of brownish or [illegible] colour; but occasionally it is blue, and in the township of [illegible] it presents varieties of greenish, yellow, and [illegible] red [illegible], though the last is extremely rare. The most Sapphire-like varieties hitherto found have been obtained from the township of Methuen, in Peterborough County.

Some of the Canadian Corundum which I have had cut has yielded small [illegible] Sapphires of fair colour.

SAPPHIRE.

Composition	Alumina.
Specific Gravity	4, or thereabouts.
Hardness	9.
System of Crystallisation ...	Hexagonal.
Form	Double six-sided pyramids or prisms, usually as rolled crystals.



ROUGH MONTANA SAPPHIRES AND RUBIES.

CHAPTER V.

STAR STONES.

CERTAIN varieties of Corundum, especially the greyish-blue semi-transparent Sapphires when cut *en cabochon*, shew a star of light, more or less perfect, reflected from the convex surface. Such stones are therefore commonly called *Star Stones*, whilst by the Ancients they were designated *Asterias*. According to Plutarch, the River Sangaris produced a gem called *Aster*, which was luminous in the dark, and was known to the Phrygians as *Ballen*, or "The King." A gem called *Asterites*, found inside a huge fish called "Pan," from its resemblance to that god, is also described by Ptolemy Hephæstion. The term Asteria has been used by different authors in various senses at various times; but there can be no doubt that Pliny understood by it the same gem that we do now. A purplish Star Sapphire was known to Pliny as the *Ceraunia*, or "Lightning-stone," and it was probably the same stone that was termed *Astrapia*.

The optical phenomenon presented by star-stones is known as *Asterism*, and its cause is to be sought in the internal structure of the crystal; all the Star-Stones exhibiting a peculiar laminated texture, and generally presenting, on the basal plane, a system of fine striations related to the direction of the lines of light, which form by their intersection the chatoyant star. In the Star Sapphires there seem to be three sets of structural planes, the edges of which intersect at angles of 60°; and when a

transverse section of a hexagonal pyramid is made, these lines are seen as triangular striæ From each set of parallel lines a narrow transverse luminous band is reflected, and the crossing of these three bands of light produces a star of six rays. Occasionally a secondary system of lines is apparent, thus giving rise to a twelve-rayed star. Great skill is required on the part of the lapidary in dealing with such stones to produce the most effective result.

Although the majority of Asterias are Sapphire, the same optical phenomenon is occasionally exhibited by other gems. The purple and reddish Corundums, when judiciously cut, shew Asterism, thus forming *Star Rubies*; and in like manner we may have *Star Emeralds and Star Garnets.*

The Orientals have ever entertained a peculiar veneration for Star Stones, but only of late years have they been of any value in England. The finest Star Ruby lately seen was valued at £200. The price of these gems is mainly determined by quality and colour; small Star Sapphires range from £2 upwards. Star Rubies obtain higher prices; but Star-stones, of a secondary rank, are of little value.

CHAPTER VI.

SPINEL AND BALAS.

UNDER the generic name *Spinel* several minerals are included, as the Spinel Ruby, the Balas Ruby, and the Pleonaste.

Differing among themselves in colour and other trivial characteristics, they all agree in possessing approximately the same chemical composition. They are, in fact, aluminates of magnesia, or compounds of alumina and magnesia, associated with variable proportions of other metallic oxides, such as those of chromium and iron, to which the colours are probably due.

Few minerals enjoy a wider range of colour than the Spinel. Among its varied tints we may mention carmine, red, reddish-brown, rose-red, various tints of orange, indigo blue, green, purple, puce, violet, and even white and yellow Some varieties are opaque and dark-coloured, or even black, but these have no value as ornamental stones. Indeed, it is only the so-called *Precious Spinel*, which is of use to the jeweller. By ancient writers the Red Spinels were probably included, with several other stones, under the general name of *Carbunculus*.

Precious Spinels are found either detached, as loose pebbles, or embedded in granular limestone, or in granite rocks. In Burma, Ceylon, and Badakshan Spinel occurs in well-formed, sharp-angled crystals which are regular octahedra; while in many gem sands it is found as rolled crystals, accompanied with zircon, garnet, magnetic iron ore, and other minerals.

The form of Spinel, which is generally that of the regular octahedron, enables it to be readily distinguished

from the true or Oriental Ruby, with which it has been sometimes confounded. It may also be distinguished by its inferior hardness, and specific gravity.

A peculiarity of Spinel is that the light which is reflected from the depth of the gem, no matter what the colour of the stone, is always of a pale yellow. The lustre is vitreous, and the gem displays every degree of transparency. The refraction is simple. It is rendered electric by friction, but not by heat; differing in the latter respect from Topaz, which is distinctly pyro-electric.

In the International Exhibition of 1862 there were two very fine Spinels; one from India was cut *en cabochon* forming an octagon-shaped stone, of perfect colour, and free from flaws. It weighed 197 carats. This was cut to an 81-carat "perfection stone." The other Spinel was also an octagon-shaped stone, of perfect colour, very "spread," and free from flaws. It weighed 102¼ carats, and was re-cut, weighing after cutting 72½ carats. It is strange that both these stones arrived from India in the same year, viz., 1861.

In the Ruby mines of Upper Burma, Spinel is a very common mineral, forming in many cases a conspicuous part of the gem-bearing detritus. Fine octahedral crystals have been found embedded in the calcspar, in which the true Rubies occur, and it is also found in beautifully sharp octahedra, and in flat hemitrope crystals, of small size, associated with Rubies in the Ruby-earth.

Spinel also occurs in Afghanistan in crystalline micaceous limestone. There are famous mines of Balas Rubies at Badakshan in Usbekistan, a part of Tartary. The mines were known to the Emperors of Delhi. They are near the Oxus, not far from Shighnan. There is a belief among the natives that two large Rubies always lie near each other: thus it is that the fortunate finder of

the one hides it until he has found a twin stone; failing this, they are said to break the large one in order to keep up the superstition.

Spinels are found in Australia, especially in New South Wales where they are by no means uncommon in auriferous deposits, as on the Cudgegong, Peel, Macquarie, Severn and other rivers, where gem-stones are found as rolled pebbles in the gravels, or drifts.

The *Balas* or *Balais* Ruby, is a dark variety of Spinel, with a tinge of blue appearing at the angles of the octahedron, which gives it a milky kind of shimmer. The colour is probably due to chromic acid. The name "Balas" or "Balaksh" applied to this stone, is said to be a corruption of Badakshan, one of the localities which, as stated above, yields the Spinel.

Pleonaste is an opaque black variety, which was called *Ceylonite*, by Romé de l'Isle, who analyzed it, with a number of other crystals brought from Ceylon. It was Haüy who, seeing its form resembled that of the Spinel, desired to give it a special position in his system of minerals, and named it *Pleonaste*, which signifies superfluity. Further investigation showed that it was in reality a black Spinel.

A black iron-spinel, known as *Hercynite*, occurs in the form of rolled crystals as a frequent companion to the Sapphires of Siam, and is termed by the gem-diggers *nin*.

SPINEL.

Composition—Alumina	... ...	72
Magnesia	... ...	28
		100

Specific gravity—
Varies from 3·59 in an aurora-red specimen to 3·71 in one of indgo-blue colour. (Prof. Church).

Hardness ... .. between 7 and 8
System ... ... Isometric or Cubic.

CHAPTER VII.

THE EMERALD.

THE Emerald, from a mineralogist's point of view, belongs to a class of stones altogether different from that which embraces the precious stones already described, inasmuch as it is essentially a mineral *silicate*, consisting largely of the substance known to chemists as *Silica*. The silica is itself an oxide of an element termed *Silicon*. In the Emerald the silica is combined with the oxides of two metals—one of them being *aluminium*, the basis of the Ruby and Sapphire; while the other is an exceedingly rare metal, known as *glucinum* or *beryllium*. The former name is derived from the sweet taste of some of its compounds—from the Greek word for "sweet"—whilst it receives the latter from its occurrence in the Beryl.

Just as it was shown that the Ruby and the Sapphire are identical, save in colour, so the chemist has found that the Emerald, the Beryl, and the Aquamarine are practically the same mineral, the distinctions between the three varieties being due to differences of colour and other characteristics of only trivial value to the chemist, though of immense importance to the jeweller as affecting their commercial value.

That the true Emerald was known to, and held in estimation by, the Ancients, may be inferred from the fact that ornaments of Emeralds have been excavated from Pompeii and Herculaneum; that similar ornaments have

been dug up from the ruins of old Rome, and have also been found on Egyptian mummies.

Pliny states that the Emerald stood high in the estimation of the Ancients, and some confirmation of this is derived from an old Hebrew tradition that if a serpent fixes its eyes on an Emerald it becomes blind. In the Bible the rainbow is said to be "like unto an Emerald."

There can be no doubt that many ancient writers confounded under the general term *Smaragdus* several distinct minerals of green colour, such as true Emeralds, green Jasper, Malachite, Chrysocolla, green Fluor Spar, and perhaps even green glass.

According to Pliny, the most celebrated Emerald mines in former times were in the rocks near Coptos; and the stones obtained from this region were admired for their brillant colour. Mohammed Ben Mansur (13th century) described the Emerald mines as being on the borders of the land of negroes, and yet belonging to the kingdom of Egypt, the stones found there being dug out of talc and red earth. De Laet thinks that the same region supplied Emeralds as late as the 17th century.

The tiara of Pope Julius II. contained an Emerald somewhat about an inch in length and one-and-a-quarter thick. It was in the shape of a short cylinder, rounded at one of its extremities. This was found probably in Ethiopia, the modern Etbai.

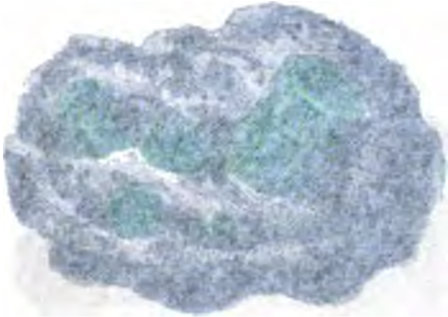
Turning to the Emeralds of the New World, we find Prescot, in his "Conquest of Mexico," writing as follows (vol. i, p. 125):—"The age of iron has followed that of brass, in fact as well as in fiction. They found a substitute in an alloy of tin and copper, and, with tools made of this bronze, could cut not only metals, but with the aid of a siliceous dust, the hardest substances,

as Basalt, Porphyry, Amethysts, and *Emeralds*. They fashioned these last, which were found very large, into many curious and fantastic forms." Elsewhere (vol. iii., p. 214), in describing certain spoils, he mentions a large Emerald "cut in pyramidal shape, of so extraordinary a size, that the base was as broad as the palm of the hand." And in another place (p. 287) mention is made of fine Emeralds of a wonderful size and brilliancy, which had been cut by the Aztecs into the shapes of flowers, fishes, and other fantastical forms.

In the Manka Valley of Peru the natives appear to have paid divine homage to a magnificent Emerald of the size of an ostrich egg, which they named the goddess of Emeralds. The priests enhanced the value by displaying it on high festivals only, when, it was alleged, Emeralds were peculiarly acceptable to the idol, and thus the temple came into possession of a vast number of these costly gems, which on the discovery of Peru by the Spaniards, fell into the hands of the conquerors; but Pizarro and his followers, "like bad lapidaries" writes Purchas, broke many to fragments, supposing they would possess the adamantine property of the Diamond.

After the discovery of Peru, Emeralds became less rare in Europe, and jewellers and lapidaries much preferred the Peruvian stones; hence the most beautiful of Emeralds are always called Spanish Emeralds. Joseph D'Acosta, who himself visited the Emerald mines of New Granada and Peru, said that at first these stones came to Europe in such numbers, that on the ship in which he returned from America to Spain, in 1587, were two chests each containing one hundredweight of Emeralds.

The Emerald is found crystallized in six-sided prisms or columns, without striations, and therefore, unlike those



THE SOUTH AMERICAN EMERALD [illegible]

desert, Porphyry, Amethysts, and *Emeralds*. They fashioned these last, which were found very large, into many curious and fantastic forms." Elsewhere (vol. iii, p. 214), enumerating certain spoils, he mentions a large Emerald cut in pyramidical shape, of so extraordinary a size, that the base was as broad as the palm of the hand." And in another place (p. 287) mention is made of Emeralds of a wonderful size and brilliancy, which had been cut by the Aztecs into the shapes of flowers, fishes, and other fantastical forms.

In the Manta Valley of Peru the natives appear to have paid divine homage to a magnificent Emerald of the size of an ostrich egg, which they named the goddess of Emeralds. The priests enhanced its value by displaying it on high festival days, when, it was alleged, Emeralds were peculiarly acceptable to the idol and thus the temple came into possession of a vast number of these costly gems which on the discovery of Peru by the Spaniards, fell into the hands of the conquerors. But Pizarro and his followers, "like bold banditti," writes Prescott, "broke many to fragments, supposing they would possess the adamantine property of the Diamond."

After the discovery of Peru, Emeralds became less rare in Europe, and jewellers and lapidaries much preferred the Peruvian stones: hence the most beautiful of Emeralds are always called Spanish Emeralds. Joseph D'Acosta, who himself visited the Emerald mines of New Granada and Peru, said that at first these stones came to Europe in such numbers, that on the ship in which he returned from America to Spain, in 1587, were twelve chests each containing four arrobas weight of Emeralds.

The Emerald is found crystallized in six-sided prisms ... with many modifications, and therefore, unlike the other

THE SOUTH AMERICAN EMERALD in Matrix

of Beryl, which are usually striated vertically. The colour varies from what is called emerald-green to grass-green, and greenish-white. Subjected to the dichroiscope, its colour is resolved into a yellowish-green and a bluish-green.

The variety of opinion as to the source of the beautiful colour of the Emerald is very interesting. According to most authorities it owes its beauty to the chromium which it contains. On the other hand, M. Lewy, who analysed with great care the Emeralds from the Muzo mines of Colombia, found that they contained organic matter in the form of some hydro-carbon, and that the intensity of the colour depended upon the amount of this organic matter contained in the Emerald. The green pigment of the Emerald was supposed by him to be similar to the colouring matter of leaves, called chlorophyll. The conclusions of M. Lewy have not, however, been verified by other chemists; and the experiments of Mr. Greville Williams and others tend to shew that the colouring matter of the Emerald is, after all, an oxide of chromium.

The *cleavage* of the Emerald is in four directions, but the only perfect cleavage is that parallel to the terminal plane. Its *fracture* is conchoidal and uneven, and its *lustre* vitreous.

The value of an Emerald depends greatly upon its colour, and freedom from flaws; a very fine dark velvety coloured stone, free from flaw, is seldom procurable. Perhaps there is no stone which suffers more than the Emerald from inequality of structure, colour and transparency.

THE EMERALDS OF MUZO.

The most famous Emerald mines of the world are those of Muzo, situated in 5° 39′ 50″ N. latitude, and

74° 25′ W. longitude, on the banks of the river Minero, about 80 miles N.N.W. of Santa Fé de Bogatá, in the Republic of Colombia. They were discovered by Lanchero in 1555, but the Spaniards did not commence working until 1568. The mines are Government property, but are leased to a Colombian-French syndicate, at a yearly rental of £2,250.

The Emerald mines are situated in a very wild country, with rough roads, in some parts almost impassable, traversing dangerous passes in the Andes. The workings are in a basin-like hollow in the mountains, suggesting the crater of a vast volcano, but the rocks are not of igneous character.

It appears that the rocks are chiefly black bituminous shales and limestone, traversed by veins of white calcite and iron-pyrites. In these veins the Emeralds occur, sometimes embedded and sometimes loose in free cavities; but their occurrence is very irregular, and the mining consequently becomes highly precarious.

About 400 native workmen are employed, under five or six overseers, in the great quarry-like excavations which constitute the Emerald mines. The working is of quite a primitive character. To obtain the Emeralds the workmen begin by cutting steps on the inclined walls of the mine, which may be a thousand feet high, in order to make firm resting-places for their feet. The overseer places the men at certain distances from each other, to cut out a wide step with the help of pickaxes and crowbars. The loosened stones fall by their own weight to the bottom of the precipice. When the rubbish has accumulated, a sign is given to let the waters loose from a reservoir above; and these rush down with great vehemence, carrying the fragments of rocks with them. This operation is repeated

until the beds are exposed, in which the Emeralds are found. On the summit of the mountains, and quite near to the mouth of the mine, are large reservoirs, whose waters are shut off by means of water-gates or sluices, which can be easily shifted when the labourers require the water. When the waters are freed, which occurs about every quarter of an hour while working, they rush with great rapidity down the walls of the mine, and on reaching the bottom of it they are conducted by means of an underground canal through the mountain into a basin.

Workings at the Muzo Mines were stopped in the middle of the last century, and it was rumoured that fires had broken out, and that the mines were unsafe. It was not until 1844 that active operations were resumed. About that time a Colombian named Paris—after whom the rare mineral *Parisite* was christened—got out some fine stones and sold them for large sums in Europe and in the United States. A French company was afterwards formed, and during the Empire all the finest stones went direct to the Paris market. At the present time Emeralds of fine colour are of great rarity.

EGYPTIAN EMERALDS.

Probably the earliest known Emeralds were those obtained from the mines in the Eastern Desert of Egypt. The scientific expedition to the Northern Etbai, despatched by H. H. the late Khedive, in the spring of 1891, made a somewhat detailed examination of the old workings, and specimens were brought home by Mr. E. A. Floyer, to whose courtesy the author is indebted for the following description of the mines.

Though the mines are mentioned by the ancient

historians Strabo, Diodorus, Agatharchides, and others, no description of them appears to have been written from actual examination. This probably arose from the difficulty of visiting them. Olympiodorus laments his ill success in this direction, and it is probable that a jealous watch was kept over the miners.

The Emeralds of Egypt, are, however, often mentioned with high praise. Cleopatra gave, as presents to ambassadors, portraits of herself engraved on Emeralds, and the stones during her reign appear to have been considered as strictly royal property.

Maundeville, 500 years ago, described Egypt as "a country of fair Emeralds."

When and under what circumstances the mines were abandoned must remain matter of conjecture. They probably shared the fate of the numerous gold mines and topaz workings which are found in their neighbourhood.

All the mines in Egypt appear to have been first worked by some unskilled people, possibly those negroid tribes, who now work the copper and iron mines in the Soudan. It was to these people that Herodotus, not knowing why they burrowed in the earth, gave the name of Troglodytes or cave-dwellers.

These people were probably driven south about 2,000 years ago by the Greek miners employed under Ptolemy after the death of Alexander the Great. At each mining town may still be seen the open-air cuttings and the rude stone dwellings of an ancient mining people. And close by these are found in almost every case, the temple, the well-built rectangular houses and covered galleries of their European supplanters. There is hardly a quartz reef which does not bear marks of working.

The Emerald mines are in the centre of a great

mineral field formed by a depression in the long range of mountains which runs along the Red Sea Coast.

To the north, in latitude 27°, this range rises into the great porphyry peaks whence Mr. Brindley brings the Imperial stone which the Romans prized for purposes of decoration.

The range is then hollow-backed, until in latitude 24°, the traveller climbs the lofty porphyry peaks of Hullus, and, seated on the edge of a wall, sheer 1,500 feet, looks over a hundred miles of sea and mountain.

Between these points, and equally between Hullus and Elba, to the south, the hills are honeycombed with gold mines, and scarified by topaz workings: the last are still in progress.

But the most interesting part of the range is that in which are found the Emerald mines of Sikait and of Jebel Zabbara, the latter word possibly a corruption of Smaragdus.

There are two main Emerald mining centres. That of Sikait, approached from the sea by the Wadi Jamal, is the largest and most extensive. Here are very ancient rock temples. The priests of old reaped a rich harvest from the superstition of the miners.

Of a later date than these rock temples, is a good masonry temple, admirably proportioned, roofed in part with great slabs of shining schist, and imposingly placed on a spur of rock running into the Sikait valley. Here are the ruins of a well-built town, and along the valley and in all the hills are some hundreds of shafts of varying depth. The hills, some 600 or 700 feet in relative height, are mainly formed of a soft talcose schist veined with quartz and consolidated by contorted beds of a brown brittle metamorphic rock.

The hills bear the appearance of a great rabbit-warren. Everywhere are holes, each with its talus of silver-grey powder streaming down the hillside. The talc occurs in solid white blocks, coloured green, and other tints, and often bright yellow like gold. When climbing the hills the feeling underfoot is that of walking on soft dead wood. Square towers mark the mountain tops. Some were watch towers, whence the watchmen guarded the miners and gazed over the blue sea, looking eagerly for the expected ships of wine and food. Other towers appear to have been magazines.

Some ten miles north of Sikait are the Jebel Zabbara mines. Here the principal shafts are in low spurs, doubled up in syncline and anticline in rapid repetition, and jutting from a mass of schist some 1,200 feet in relative height.

Here, among the ruins of the old houses, are the stone houses and ovens of the Albanian miners who in 1819 were placed by Muhammad Ali under the supervision of Cailliaud, a young French silversmith who earned, later on, a great reputation as traveller and mineralogist in the Soudan with Ibraham Pasha.

Cailliaud's account of his discovery of these mines has been published by the French Academy. Why they were abandoned is nowhere stated, but it was probably owing to Cailliaud being commanded to accompany the expedition to the Soudan, and to the stoppage of supplies to the miners the moment his presence was removed.

These Albanians did an immense amount of work if they did all that has been done. In one valley the silvery talus cannot amount to less than 20,cco to 25,000 tons. They made good square-sectioned shafts. Across them are wedged stout boughs of trees. Mr. Floyer descended

one shaft and took out string to the length of 450 feet. The descent was a steep incline, with occasional perpendicular drops of six to ten feet. At this depth was a chamber where were ranged some thirty baskets of ore all ready for raising to the surface. It was difficult to believe that the baskets were seventy years old.

The old Emerald mines of Egypt have recently been visited on my behalf by Mr. H. W. Seton-Karr. In December, 1897, he explored the ancient workings of Sikait and of Zabbara, and brought home a quantity of rough Emerald, some of which has yielded stones of excellent quality. The prevailing rock, forming the matrix of the Emerald, seems to be mica schist, of various colours. In the white schist he found small Emeralds of brilliant green colour; in the grey schist, the crystals were larger but not of such bright hues; whilst in the black schist, the Emeralds though very large are of such poor quality as to be practically worthless.

It seems unlikely that these mines, which were so extensively worked by the ancients and yielded valuable gems like those of Cleopatra, should be exhausted. Believing that they will be well-worth re-opening and working by our improved modern methods of mining, I have applied to the Egyptian Government for a concession, and at the time of writing am awaiting a reply to my application.

RUSSIAN EMERALDS.

Emeralds were first discovered in Russia in 1830, when a charcoal-burner found crystals of the mineral at the roots of a tree which had been overturned by the wind. He took the crystals to Ekaterinburg, where the traders in precious stones at once recognized their value. This

discovery led directly to the regulated working of the bed, which yielded in the first years some fine specimens—one of the extraordinary weight of 101¼ carats; but, unfortunately, the yield gradually decreased.

The Emerald mines are situated on the right bank of the River Tokowoia, about 85 versts to the east of Ekaterinburg, on the Asiatic slope of the Ural mountains. The Emeralds occur in a matrix of mica-schist, and are associated with Alexandrite, Chrysoberyl, Phenacite, etc. Some of these Emeralds are of very fine colour, but most of them—especially the large crystals—are of inferior quality, being much flawed and in some cases containing enclosures of mica. At present but very few Emeralds are yielded by Russia.

AUSTRIAN EMERALDS.

Crystals of Emerald are found embedded in a dark mica-schist in the Habachthal (or Heubachthal), which is situated in a wild part of the Salzburg Alps, and at a great elevation above sea level. Some of the crystals display excellent colour, but most of them are unfortunately small, and of no importance commercially. The occurrence, however, is of scientific interest, inasmuch as the Emerald is here found in mica-schist, exactly as it occurs in the Urals and in Egypt. The Salzburg Emeralds are said to have been known to the ancient Romans, and at the present time the locality is being explored in the hope of discovering a supply of stones fit for jewellery.

Emeralds are also found near Snarum, in Norway, but only as mineral specimens.

AUSTRALIAN EMERALDS.

In the year 1890, attention was called to the discovery of Emeralds in New South Wales The stones were first

observed among the material thrown out from certain tin-workings, and investigation soon traced them to their source in an actual vein. The locality was situated about seven miles North-East of Emmaville, better known as Vegetable Creek, not far from the Queensland frontier.

The Emeralds occurred in a true fissure *lode* formation, from 2 to 4 feet wide, between well-defined walls, and were found in shoots or bunches at intervals.

The country is composed of granite or slate, and it was almost at the junction of the two formations that the first deposit of Emeralds was discovered, at a depth of 11 feet from the surface.

The Emeralds were associated with quartz, topaz, fluor-spar, mispickel (arsenical pyrites), tin-stone and kaolin. The locality was visited by Prof. E. David, at that time Government Geologist, who reported favourably upon the occurrence of the mineral, and the prospects of the exploration.

Workings were carried on for some years by the Emerald Proprietory Company, and a large number of stones were obtained, one weighing as much as 23 carats. Most of them however, were of pale tint, and lacked the rich colour of typical Emerald, and it is believed that the workings were ultimately abandoned as unremunerative.

EMERALDS OF THE UNITED STATES.

Although rough beryls, sometimes of large size, are known in many parts of the United States, the only State which has yielded the chrome-green variety, forming the true Emerald is North Carolina.

In 1880, Mr. W. E. Hidden discovered Emeralds at Warren farm in Alexander County, where they were

associated with the green spodumene which will be subsequently described in the chapter on Hiddenite. The locality was considered sufficiently promising to justify the formation of a Company to work the stones, called the Emerald and Hiddenite Mining Company; but the workings have not proved successful.

EMERALD.

Composition—	Silica	68
	Alumina	18
	Glucina, &c.	14
		100
Specific Gravity	... ...	2·7
Hardness	... ...	7·5
System	... ...	Hexagonal.
Form	Hexagonal and di-hexagonal prisms, variously modified.	

CHRYSOBERYL CAT'S EYE, in the Rough (Part Polished).

CHAPTER VIII.

THE TRUE OR ORIENTAL CAT'S EYE,

OR CYMOPHANE.

THE true or Oriental Cat's Eye is a rare variety of the *Chrysoberyl* or *Cymophane*, a stone of extreme hardness, in this respect being only inferior to the Diamond and the Sapphire. It is characterised by possessing a remarkable play of light in a certain direction, resulting, it is supposed, from a peculiarity in its internal structure, which appears to be minutely striated. This ray of light, or "line" as it is called by jewellers, shines in fine and well-polished specimens with a peculiar opalescent lustre. In India these lines of light are called "betas," and the price increases according to these "betas."

The Chrysoberyl Cat's Eye comes principally from Ceylon, where it is found in company with [illegible] Zircons, and other gem-stones, and [illegible] found in China [illegible] of various [illegible] pale-straw colour through all shades of [illegible] very pale apple-green to the deepest [illegible] specimens, much sought for by Americans, [illegible] black. The line, no matter what ground-colour [illegible] may possess is nearly always white, and more [illegible] but occasionally, but very rarely, we even [illegible] golden hue. This lustre is most beautiful [illegible] full sun light, or by gas light, when the [illegible] defined and vivid.

[illegible] in the [illegible]

CHAPTER VIII.

THE TRUE OR ORIENTAL CAT'S EYE.

THE CHRYSOBERYL.

THE true or Oriental Cat's Eye is a rare variety of the *Chrysoberyl* or *Cymophane*—a stone of extreme hardness, in this respect being only inferior to the Diamond and the Sapphire. It is characterized by possessing a remarkable play of light in a certain direction, resulting, it is supposed, from a peculiarity in its internal structure, which appears to be minutely striated. This ray of light, or "line" as it is termed by jewellers, shines in fine and well-polished specimens with a phosphorescent lustre. In India the lines of light are called *betas*, and the price increases according to these "betas."

The Chrysoberyl Cat's Eye comes principally from Ceylon, where it is found in company with Sapphires, Zircons, and other gem-stones; and it has also been found in China. It is of various colours, ranging from pale-straw colour through all shades of brown, and from very pale apple-green to the deepest olive. Some specimens, much sought for by Americans, are almost black. The line, no matter what ground-colour the stone may possess, is nearly always white, and more or less iridescent; occasionally, but very rarely, however, the line is of a golden hue. This lustre is most beautiful when seen in full sun-light, or by gas-light, when the lines become more defined and vivid.

This gem is valued principally according to the perfection and brilliancy of the luminous line, which should be sharp and well-defined, not very broad, and should run evenly from end to end across the middle of the stone. The colour does not much influence the value, some jewellers preferring one tint, some another. On the whole, perhaps, the most popular tints are honey colour, clear apple-green, and dark olive: all of these form a splendid back-ground, and contrast well with the line. It is quite impossible to give any satisfactory scale of values for this gem, its estimation depending much on personal appreciation and taste.

In India it has always been much prized; it is held in peculiar veneration as a charm against witchcraft, and is the last jewel a Cingalese will part with. The specimens most esteemed by the Indians are those of a dark olive colour, having the ray so bright on each edge as to appear double. It is indeed wonderfully beautiful, with its soft, deep colour, and mysterious gleaming streak, ever shifting, like a restless spirit, from side to side as the stone is moved; now glowing at one spot, now at another. No wonder that an imaginative and superstitious people regard it with awe and wonder, and believing it to be the abode of some genii, dedicate it to their gods as a sacred stone.

It should be pointed out that much confusion exists with reference to the Cat's Eye, since this name is also applied to certain fibrous varieties of Quartz. The presence of parallel fibres of asbestos included in the Quartz, gives rise to a more or less definite band of light, with a silky lustre, running across the direction of the fibres when the stone is cut with a convex surface (*en cabochon*). This chatoyant quartz is found largely in Ceylon, and on the west coast of India, where it is known as "Coast Cat's

Eye": it occurs chiefly in various shades of yellow, or brown. A greenish variety is found near Hof, in Bavaria, and is largely cut as an ornamental stone; but none of the Quartz Cat's Eye has much value. Even when most perfect, it cannot be compared for beauty with the Oriental Cat's Eye, for which, side by side, it ought not to be mistaken, even by the uninitiated.

It may be useful to contrast the characteristics of the two minerals:—

Description of true Chrysoberyl Cat's Eye.	*Description of Common Quartz Cat's Eye.*
Colour—Various shades of yellow, brown, green, and black.	Colour—Various shades of yellow, greyish green and brown only.
Ray—Iridescent.	Ray—Dull.
Lustre—Brilliant.	Lustre—Dull.
Hardness ... ... 8·5	Hardness ... ... 7.
Specific Gravity ... 3·8	Specific Gravity ... 2·6
Infusible before the blowpipe, and not affected by acids.	Melts with Soda to a clear glass. Soluble in Hydrofluoric Acid.
Sometimes shewing a beautiful dichroism.	Never dichroic.
Approximate Chem. Com. { 80 alumina, 20 glucina; colouring matter—oxide of iron.	Chem. Com. { 48 Silicon, 51 Oxygen, with a small amount of oxide of iron, &c.

CHAPTER IX.

ALEXANDRITE.

THIS stone was named after the Czar of Russia, Alexander II., having been discovered on his birthday, in 1830. It owes its celebrity to its prominent hues of *red* and *green*, and as these are the military colours, the stone became much sought after in Russia. The Russian Alexandrite can rarely be shown to the best advantage in consequence of defects of structure, as it is usually flawed with crevices which make successful cutting and polishing extremely difficult. The variety found in Ceylon is more easy of manipulation.

Alexandrite is especially remarkable for its strongly marked difference of colour, according as it is viewed by natural or by artificial light. The finest stones present a bright green, or deep olive green colour, by daylight; whereas, at night, artificial light, such as that of gas or a candle, brings out a soft columbine red or raspberry tint, or purple. It has been said that the Alexandrite is an emerald by day and an amethyst at night.

The Alexandrite is strongly dichroic, while some varieties are even trichroic.

Chemical analysis shows that the Alexandrite is a variety of Chrysoberyl. The author has seen, in the course of his experience, two or three stones with a perfect Cat's Eye line, yet subject to the characteristic change of colour by artificial light: such stones are called *Alexandrite Cat's Eyes.* In order to display the line of light, it is, of course, necessary to cut the stone *en cabochon* instead of facetting it.

ALEXANDRITE, in the Rough.

CHAPTER IX.

ALEXANDRITE.

THIS stone was named after the Czar of Russia, Alexander II., having been discovered on his birthday, in 1830. It owes its celebrity to the prominent hues of *red* and *green*, and as these are the military colours, the stone became much sought after in Russia. The Russian Alexandrite cannot usually be cut to the best advantage in consequence of defective structure, as it is usually flawed with crevices which render successful cutting and polishing extremely difficult. The variety found in Ceylon is more easy of manipulation.

Alexandrite is especially remarkable for its strongly marked difference of colour, according as it is viewed by natural or by artificial light. The finest stones present a bright green, or deep olive green colour, by daylight, whereas, at night, artificial light, such as that of gas or a candle brings out a soft columbine red or raspberry tint or purple. It has been said that the Alexandrite is an emerald by day and an amethyst at night.

The Alexandrite is strongly dichroic, while some varieties are even trichroic.

Chemical analysis shows that the Alexandrite is a variety of Chrysoberyl. The author has seen, in the course of his experience, two or three stones with a perfect cat's-eye line, yet subject to the characteristic change of colour by artificial light. Such stones are called *Alexandrite Cat's-eyes*. In order to display the line of light, it is, of course, necessary to cut these stones *en cabochon* instead of facetting, it

ALEXANDRITE, in the Rough.

The original Alexandrite came from the Emerald mine of Tokowoia, in the Ural mountains, but was found only in small quantities. The principal supply is now obtained from Ceylon, where, however, it is far from plentiful. The market value of this stone is extremely variable: and sometimes as much as £20 per carat is paid for a fine stone.

ALEXANDRITE.

Composition:—

Alumina	79
Glucina	18
Iron and chromic oxide, &c.	3
	100

Specific Gravity	3.7
Hardness	8·5
System of Crystallization ...	Trimetric
Form of Crystal	Usually six-sided twins.

CHAPTER X.

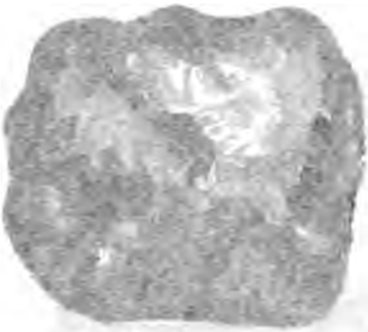
THE OPAL.

NICOLS in his curious old book entitled "A Lapidary," written two centuries and a half ago, gives a quaint description of this lovely stone. He says, "The Opal is a precious stone which hath in it the bright fiery flame of the Carbuncle, the fine, refulgent purple of an Amethyst, and a whole sea of the Emerald's green glory; and every one of them shining with an incredible mixture and very much pleasure." Boetius described it as "the fairest and most pleasing of all other jewels, by reason of its various colours." Cardanus says, "I bought one for 15 crowns, which gave me as much pleasure as a Diamond of 500 aureos."

There is a strange history given by Pliny of an Opal about the size of a hazel nut, which was possessed by the Senator Nonius, and was valued at £20,000 of our money. Nonius, who was proscribed by Marc Anthony for the sake of this gem, made his escape, carrying off the ring with him, as the sole relic of his fortune. He preferred exile with his Opal to living in Rome without it.

The Opal is chemically a hydrous form of silica, and a great deal of the mineral is quite unlike the beautiful variety used for jewellery.

Several kinds of Opal are indeed known to the mineralogist. Most of it is destitute of beauty, and is hence termed *Common Opal.* Other specimens present translucency but no colour; these are distinguished as



QUEENSLAND OPAL in the Matrix.

CHAPTER X.

THE OPAL.

NICOLS in his curious old book entitled "A Lapidary," written two centuries and a half ago, gives a quaint description of this lovely stone. He says, "The Opal is a precious stone which hath in it the bright fiery flame of the Carbuncle, the most refulgent purple of an Amethyst, and a whole sea of the Emerald's green glory; and every one of them shining with an incredible mixture and very much [illegible]." [illegible] has described it as "the fairest and most [illegible] of other jewels, by reason of its various [illegible]" [illegible], "I bought one for 15 crowns, which [illegible] as much pleasure as a Diamond of 500 crowns."

There is a strange history given by Pliny of an Opal [illegible] of a hazel nut, which was possessed by the Senator Nonius, and was valued at £20,000 of our money. Nonius, who was proscribed by Marc Anthony for the sake of this gem, made his escape carrying off the ring with him, as the sole relic of his fortune. He preferred exile with his Opal to living in Rome without it.

The Opal is chemically a hydrous form of silica, [illegible] a great deal of the mineral is quite unlike the [illegible] variety used for jewellery.

Several kinds of Opal are indeed known to the mineralogist. Most of it is destitute of beauty, and is hence termed *Common Opal*. Other specimens present translucency but no colour; these are distinguished as

QUEENSLAND OPAL in the Matrix.

Semi-Opal. Certain Opals from Zimapan, in Mexico, possess a bright orange-red tint, and are used to a limited extent as an ornamental stone under the name of *Fire-Opal.* But the rare and beautiful variety, which is familiar to every one by its unique colours, is distinguished scientifically as *Precious* or *Noble Opal,* though known to the jeweller simply as "Opal."

The value of the Opal lies in the depth and variety of the rainbow-like tints which it exhibits. This colour is not due to any pigment in the stone, but is an optical phenomenon, probably the result of a number of fissures which traverse it, the light being decomposed by the delicate striations on the walls of these microscopic crevices, thus giving rise to "diffraction." The optical properties of the Precious Opal have frequently been made the subject of study by physicists in this country, notably by Sir David Brewster, Sir William Crookes, and Lord Rayleigh.

In some varieties the colours are more or less evenly distributed, and one set of shades will predominate in one part of the stone, and other colours in another part; or the distinct tints will run in parallel bands. In other specimens the colours are made up of small regular angular patches of every hue, and these polychromatic stones are known as *Harlequin Opals.* Recently I have found a piece with a luminous ray running down the middle, as in a cat's eye, and I have therefore called this *Cat's-Eye Opal.*

The Opal is a non-crystalline mineral. When first taken out of the earth it is not very hard, but subsequently, by exposure to the air, its hardness is increased: nevertheless, it always remains a soft stone compared with other gems. Before the blow-pipe the Opal is infusible, but the water driven off by heat renders it opaque. It

has the curious property of improving by the warmth of the hand, which brings out the brilliant tints for which this stone is so famed.

HUNGARIAN OPALS.

The Precious Opal, used in jewellery, was formerly obtained almost exclusively from Hungary. It was called *Oriental Opal* by the Greek and Turkish merchants, who obtained it from the celebrated mines near Czerwenitza, and then carried it to the East for the purpose of giving the title Oriental to it, which always conveyed a sense of goodness and value to stones.

The Hungarian Opal was found in the Tokai-Esperieser mountains, not far from Czerwenitza, the principal mines being in the Libanka mountain, west of Dubnik. It is believed that it was from this district that the ancient Romans obtained their Opal. The matrix of the gem is an old lava of brown or grey colour, known as andesite. In the clefts and cavities of this rock, especially in the decomposed part, the Opal is irregularly distributed as veins and nests. It is probable that alkaline thermal waters, from volcanic sources acted upon the rock, decomposing some of its silicates and setting free the silica, which was deposited from the solution in a gelatinous condition and solidified in the form of Opal.

The opal mountains have been extensively worked by subterranean galleries of great extent; the rock being brought down by blasting, and the shattered fragments then carefully picked over by hand. Most of the Hungarian Opal is of the common variety, and specimens displaying vivid colours fit for jewellery are comparatively rare.

There is, in the Imperial Cabinet of Vienna, an Opal

from Hungary nearly as large as a man's fist, and weighing 17 ozs. Perhaps the finest Opal of modern times was that of the Empress Josephine, which was called the "Burning of Troy," from the numberless red flames blazing on its surface.

AUSTRALIAN OPALS.

Of late years Precious Opals of singular beauty have been brought in quantities from Australia. Attention was first directed to their occurrence in Queensland by Mr. H. W. Bond, who found them near Cooper's Creek, which runs into the Barcoo River. Since then several other localities in Queensland have been found to yield Opal; some of the most important deposits being at Fermoy, or Sandy Creek, situated 125 miles west of Longreach, and 90 miles from Winton.

The Queensland Opal occurs in veins and pipes in sandstone, and especially in brown ferruginous nodules. By probing the soft sandy rock, the hard ironstone concretions are detected; and on breaking them open, the Opal is seen as an incrustation on the walls of the cracks. The opaline layer is usually but thin, and advantage is sometimes taken of these layers to cut cameos of Opal on an ironstone matrix.

A few years ago, Mr. G. J. Hooley, in tracking a wounded kangaroo, in a remote part of New South Wales, found Opal, and this discovery led to the opening up of the White Cliffs' field. This locality is situated on the River Darling, about 50 miles from Wilcannia. The Opal occurs in Sandstone of Upper Cretaceous age, corresponding to the Desert Sandstone of Queensland; it occupies vertical and horizontal fissures in the rock, yet the actual matrix of the Opal is not sandstone, but a whitish substance described variously as kaolin and as marl-stone. It is

notable too, that the Opal forms curious pseudomorphs and sometimes takes the form of shells, belemnites, reptilian bones and fossil-wood.

Another Opal locality in New South Wales, is at Rocky Bridge Creek, where the mineral occupies the cavities in a decomposed vesicular lava, of andesitic type.

It should be noted that Australia occasionally sends us *Black Opals*, which in some cases are very beautiful, exhibiting variegated colours on a black ground.

Opal is also recorded from New Zealand, but this locality is of no commercial importance.

MEXICAN AND HONDURAS OPALS.

Opal is found in several localities in the State of Queretaro, especially at Esperanza, about 10 leagues north-west of San Juan del Rio. Here the Opal has been extensively worked in porphyry, and some of the material from these mines displays a good deal of fire. The Mexican "fire Opal" is obtained chiefly from the porphyry of Zimapan.

Opal also occurs in Honduras, in the Department of Gracias, and in Guatemala. Most of this Central American Opal is more transparent and less fiery than that from Hungary, but the conditions of its occurrence seem to be very similar in the two localities. It occurs in veins running through rocks of trachyte. The Honduras Opal is apt to lose its colour, and very little of it comes into the market.

Opal is also recorded from Crooke Co., Oregon.

OPAL.

Composition —	Silica, with 10 to 12 per cent. water.
Specific Gravity	2 to 2·2.
Hardness...	5·5 to 6.
Form	Amorphous.

CHAPTER XI.

THE TURQUOISE.

UNDER the name of *Callais* or *Callaina*, Pliny describes a greenish gem-stone, which has generally been regarded as our modern Turquoise. This identification, it is true, is open to some doubt, but it is, nevertheless, the custom of many mineralogists, to designate the Turquoise in scientific language by the name of *Callaite*. In popular phraseology, however, the beautiful stone is invariably called Turquoise.

Thomas Nicols, in his "Lapidary," says, "The Turquoise is a hard gem, of no transparency, yet full of beauty: its colour is sky-blue, out of a green, in which may be imagined a little milkish infusion. A clear sky, free from all clouds, will most excellently discover the beauty of a true Turquoise." Its exquisite colour, which loses nothing by candle-light, is no doubt owing to the presence of a certain quantity of phosphate of copper. Those specimens of the Turquoise which retain their colour perpetually, are said to belong to the "Old Rock," and are very scarce; while those that lose their colour, or become green by exposure, are ascribed to the "New Rock."

The Turquoise does not occur crystallised, but is found only in a compact form, having no cleavage, but possessing a conchoidal fracture. It is infusible before the blow-pipe, but is readily affected by acids. Chemically it is a phosphate of alumina, in a hydrated condition; and its composition has been investigated with great care by Prof. A. H. Church.

It is doubtful whether the true Turquoise was known to the Ancients; but in the Middle Ages it was well known and highly valued, and few stones had such wonderful gifts and virtues attributed to them as this had. Yet to realise these advantages it was a necessary condition that the stone should have been received as a gift. Even to this day, in Russia, there is a proverb, "That a Turquoise given by a loving hand carries with it happiness and good fortune;" and another, "That the colour of a Turquoise pales when the well-being of the giver is in danger."

The Shah of Persia has long been credited with the possession of the finest Turquoises in existence, for Nishapur, in Khorassan, the locality from whence the most precious of these stones is obtained, is within his dominions; and it was said that the best Turquoise was invariably picked out and retained by him, whilst the poorer specimens only were permitted to go into the market.

The Orientals cut texts from the Koran on Turquoise and fill in the characters with gold. There are some very good specimens of engraved mineral Turquoise, Nicols speaks of one possessed by the Duke of Etruria, which was the size of a hazel-nut, and had the image of Julius Cæsar engraved on it. There are two in the collection of the Duke of Orleans, on one of which is engraved an image of Diana, and on the other that of the Empress Faustina. A jeweller in Moscow at one time possessed a Turquoise two inches long, cut in the shape of a heart, and said to have belonged previously to Shah Nadir, who wore it as an amulet. A verse from the Koran is inscribed upon it in gold, and £780 was the price asked for it.

Discoveries in the land of Midian have shewn that three Turquoise mines exist there; the northernmost, at Aynuneh already worked, the southernmost, near Ziba

(still scratched by the Arabs), and the central one, not known precisely save to the Bedouins, who call it Jebel Shekayk. But all the stones from these localities soon lose their colour.

The Arabian Turquoise, though no longer worked, was highly prized by the ancient Egyptians, who opened Turquoise-mines in the Wady Maghara, in the Desert of Sinai. We know from existing inscriptions that the copper and turquoise mines of the Sinaitic Peninsula were taken possession of by Seneferu, a king who reigned as far back as the fourth dynasty, at the very beginning of authentic Egyptian history; and that these mines were worked to about the end of the 19th dynasty. The Turquoise occurs there either in nodules scattered through a base of red marl, or in veins running through red sandstone. The mines were visited and described some years ago by Mr. H. Bauerman.

The late Major MacDonald sent to the Exhibition of 1851 some fine Turquoises which he had obtained from the red sandstone quarries in the Desert of Arabia. Egyptian Turquoises, however, are of only small value, because their colour usually fades when exposed to the light. So it happened with those exhibited. Harry Emanuel, and myself purchased one of them for the large sum of £2,000; but the colour soon faded, and most of the money was lost.

It is known that Turquoise was extensively worked by the ancient Mexicans previously to the discovery of America, and it is probable that this was at least one of the stones known under the name of *Chalchihuitl*, and noticed by Bernal Diaz, Torquinado, and others. The Spaniards found that this "green stone" was highly esteemed for personal ornaments and for the temples of the gods; and

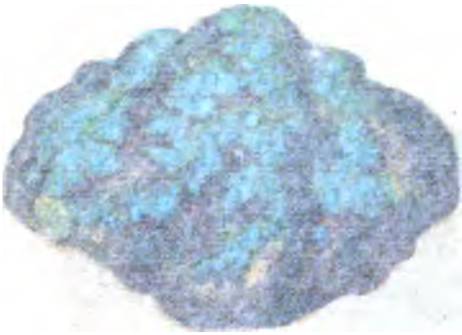
indeed it was relatively more valuable than gold ; an ear-ring of it being deemed a fair exchange for a mule.

Of late years attention has been directed to the ancient workings for Turquoise at Los Cerillos, about 24 miles south-west of Santa Fé, in New Mexico. It is there found in little veins or nuggets, covered on the exterior with a white tufaceous crust ; but stones of much commercial value are comparatively rare, though lately some fine stones have come to hand. Many tons of the rock may be crushed without producing a single specimen.

Some of the Mexican Turquoises are of a fine blue colour, but are often disfigured by white spots which appear when the stone is polished. Most of these Turquoises, however, incline to green, and, in some specimens the green colour predominates. The chemical composition of the mineral from Los Cerillos has been made the subject of careful investigation by Prof. F. W. Clarke, the chemist to the Geological Survey of the United States.

The old excavations at Los Cerillos are of enormous extent, pits having been dug in the solid rock to a depth of 200 feet. About two centuries ago a sudden inundation broke in upon the unfortunate Indians who were working in the subterranean galleries, and killed about one hundred of the workmen. So great was the destruction generally that the enterprise was abandoned. But of late years workings have been resumed ; and a firm of New York jewellers working some of the mines has obtained some very fine stones.

Turquoise of green colour is also found in Cochise County, Arizona, at a locality known as Turquoise Mountain, which, was worked on a considerable scale by the ancients. The mineral is likewise known to occur in Mineral Park, Arizona ; and at a few localities in Nevada,



TURQUOISE in the Matrix.

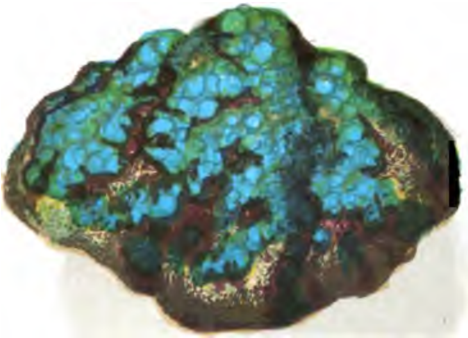
[illegible]uced it was relatively more valuable than gold; an ear-ring of it b[illegible], deemed a fair exchange for a m[illegible].

Of late y[illegible]s attention has been directed to the [illegible] workings for Turquoise at Los Cerillos, about [illegible] south-west of Santa Fé, in New Mexico. It is there [illegible] in little veins or nuggets, covered on the exterior with [illegible] tufaceous crust; but stones of much commercial [illegible] are comparatively rare, though lately some [illegible] have come to hand. Many tons of the rock may be crushed without producing a single specimen.

Some of the Mexican Turquoises are of a fine [illegible] colour, but are often disfigured by white spots which appear when the stone is polished. Most of the[illegible], however, incline to green, and, in some specimens, [illegible] colour predominates. The chemical composition [illegible] mineral from Los Cerillos has been made the [illegible] investigation by Prof. F. W. Clarke, the chemist [illegible] Geological Survey of the United States.

The [illegible] excavations at Los Cerillos are of enormous extent, [illegible] having been dug in the solid rock to a [illegible] [illegible] feet. About two centuries ago a sudden inundation broke in upon the unfortunate Indians who were working in the subterranean galleries, and killed about one hundred of the workmen. So great was the destruction [illegible] that the enterprise was abandoned. [illegible] of late [illegible] workings have been resumed; and a firm of New York jewellers working some of the mines has obtained [illegible] [illegible].

[illegible] of green colour is also found in [illegible] County, [illegible] at a locality known as Turquoise Mountain, which [illegible] worked [illegible] considerable [illegible] [illegible]. The mineral is likewise known to occur in [illegible] Park, Arizona; and at a few localities in Nevada.



TURQUOISE in the Matrix.

especially in Lincoln Co., at the foot of Sugar Loaf Peak. California also yields Turquoise, and Dr. G. Eisen has lately discovered some ancient workings, perhaps Aztec mines, in a desert region in Southern California.

A few years ago, Turquoise was found in Victoria, in Australia, the locality being near the Hedi, in the King River district, where the mineral occurs in veins, running through old slaty rocks, probably Silurian. This deposit has been actively worked.

Turquoise has also been discovered in the district of Bodalla, in New South Wales, but the stone is of no commercial importance.

THE PERSIAN TURQUOISE MINES.

The famous Turquoise mines of Khorassan in Persia were described officially in 1884, in a report drawn up for the British Legation at Teheran by General Houtum Schindler, who had held office as Director of the Mines, and Governor of the Mining District. The Shah had granted a concession of the mines for fifteen years to the Mukhbur-ed-Dowleh, who associated himself with several partners. Gen. Schindler, after managing the mines for about a year, found so many difficulties in working under this Company that he left in May, 1883. For much of the following information we are indebted to his Report.

The Turquoise mines are situated in the Bâr-i-Madèn, a district of the Nishâpûr province, about 40 miles north-east of Sabzvâr, and 32 miles north-west of Nishâpûr, in the north-eastern part of Persia, under latitude 36° 28′ N., longitude 58° 20′ E. The mountains of the district consist of nummulitic limestone and sandstones, resting on clay-slates, and enclosing great beds of gypsum and rock-salt. On the north of the Madèn valley, the stratified

rocks are broken through by porphyries and greenstones, and are consequently much metamorphosed. The Turquoise-bearing ridge, which rises to a height of 6,655 feet, consists of these eruptive and metamorphosed rocks. The Turquoises form veins in the strata.

The inhabitants of the Madèn-village are entirely occupied with the mining, cutting and selling of Turquoises. The gain has made the people careless of anything else, yet there are very few of the inhabitants who possess much. A good Turquoise is found, and the money obtained by its sale is spent at once; one can often see at the mines, men who yearly pay 60 tomans* to the Government, and who gain quite 150 tomans besides, having nothing to eat.

The Turquoise mines are of two kinds: (*a*), the mines proper, with shafts and galleries in the rocks; and (*b*), the Khâkî mines or diggings in the detritus of disintegrated rocks washed down towards the plain.

(*a*). The mines proper. The most easterly, and according to all accounts the oldest mine is the *Abdurrezzâgî* which was formerly called the Abû Ishâgî, and is with that name mentioned in old books. Its mouth is at the absolute height of 5,900 feet; it is a very extensive mine, and has a depth of 160 feet vertical from its mouth. For the last few years, very few Turquoises have been obtained from this mine, but its Turquoises are esteemed more than those of other mines. Close to this mine, and in the same valley, are the *Surkh*, *Shâperdâr* and *Aghâlî* mines, which are at present neglected.

A little to the west of the Abdurrezzâgi valley, is the "*Derreh-i-Safîd*" the White Valley, with the old mines *Mâlekî*, the upper and lower *Zâkî*, and the *Mîrzâ Ahmedî*. The former three are immense mines, but almost entirely filled up with débris.

* The value of the *toman* was, in 1884, 6*s.* 8*d.*

The Turquoises of the "*White Valley*" though very good, are not so fine as those of the *Abdurrezzâgî.* Many Turquoises, generally small, are found in the rubbish of the old mines; and are much prized for their colour.

In the lower *Zâkî*, now a vertical shaft of 60 feet in depth, and about 250 feet in circumference, it may be plainly seen how the mines have got to their present ruined state. Vertical shafts were formerly cut into the rock for lighting and ventilating the mine, while the entrance of the mine was by lateral galleries driven in on the slopes of the mountains. Schindler thinks it very probable that the mines were, as late as the first quarter of the last century, worked by the Government. When the Sefâvîeh dynasty came to an end, the mines were neglected and left to the people of the village, or perhaps, as now, farmed to them. The farmers thought of only getting a quick return for their money, and cut away the rock wherever they saw any Turquoises, exactly as they do at the present day. As a result the supporting pillars and the rock between the different shafts were cut away, and the roof, so to say, of the old mine, fell down, filling it up. The three above-mentioned mines have been filled up in a similar manner.

The mouth of the *Mîrza Ahmedî* mine, which was probably once a part of the Zâkî mines, lies about 80 feet lower than that of the Zâkî mine, and goes down about 80 feet vertical. It also has very good Turquoises, but working in it is very precarious on account of the bad state of the galleries, and the amount of loose rubbish they contain.

The next valley is the *Derreh-i-Dar-i-Kûh.* In it are several important mines, the *Kerblедi Kerîmî*, the *Dar-i-Kûh*, and others. The *Dar-i-Kûh* mine is very deep, going

down about 150 feet vertical. It is an old and very extensive mine, and some of its galleries continue as far as *Zâkt* mine; it is very dangerous on account of the rubbish it contains; the rubbish is badly propped up by stones and small sticks, and several labourers have been buried in it. All the mines in the *Dar-i-Kûh* valley are worked, and contain good Turquoises.

Further west is the "*Derreh-i-Sîyah*," the Black Valley, with the old *Ali Mirzâï* (a contraction of Ali Murtezâ), and the *Reîsh* mines.

The *Ali Mirzâï*, particularly the lower one of that name, is very dangerous. The rock which is soft and much disintegrated, often falls and fills up the mine. A part of this mine is called the "*Bi-râh-rô*," the shaft "without a road:" to go down into it is very difficult. The Turquoises of the *Ali Mirzâï* are not good, as their colour soon fades.

A little to the south of the *Ali Mirzâï* mines lies the *Khurûj* mine, very extensive, but partly filled up; it had some sixty years ago, very good Turquoises, and is at present not worked.

On the top of the *Reîsh* mine, in the same valley, a vein of Turquoises was discovered a few years ago, and a new mine was opened there with the name of "*Sar-i-Reîsh*" (the head of the Reîsh). In it are found Turquoises of fine colour and great size, but the colour soon fades and the Turquoise becomes a dirty green, with white and grey spots. As long as these Turquoises are kept damp they preserve their colour, but if once they get dry they are worth very little. A Turquoise as large as a walnut and of a fine colour was found in this mine in 1882, and was presented to the Shah; but, after it had been two days with His Majesty, it became green and whitish, and was found to be worth nothing.

The next valley called the "*Derreh-i-Sabz*," the green valley, contains the old Ardelânî and Sabz mines, and the new Anjîrî mines. The *Ardelânî* was once a very great mine; more than twelve old shafts, now filled up, are still to be seen; its present entrance is by a large artificial cave with a dome-like roof; it has a vertical depth of 85 feet, and is very badly ventilated, having several galleries with foul air. Such galleries are called "chirâgh-kush," *i.e.*, lamp extinguishers. The Ardelânî Turquoises are not good. A "Jowâher nâmeh" (Book on Jewels) written during the seventeenth century, mentions that Turquoises of the most inferior quality were obtained from the Ardelânî.

The *Sabz* mine has, as its name implies, green Turquoises, and is at present filled up.

The *Anjîrî* mines, which have their name from some fig trees growing in the valley (Anjîr=fig), are new mines. They produced during the last few years a very great quantity of Turquoises, which had a fine colour, and sold well. The colour, however, soon faded, and the possessors of these Turquoises are now far from satisfied with their purchases. These stones were sent to Europe and kept moist in earthenware pots till they were sold; but when removed from the damp they lost colour, and in a year or two became quite white.

The next and last, also the most westerly valley, is the one with the *Kemerî* mine. This mine, which is full of water, has some thick veins of Turquoises, but the stones are of no use for rings, being generally worked into cheap jewellery.

There are many more mines with names, perhaps a hundred, and more than a hundred nameless ones, but they are either parts of those enumerated above, or they

are unimportant. Work in these mines is carried on by means of picks, and crowbars, and gunpowder. Blasting with gunpowder has come into vogue only within the last thirty years: formerly all the work was done by picks, and much better; for the picks extracted the Turquoises entire, while the gunpowder though it does more work, breaks the stones into small pieces.

(*b*). The *Khakî* mines are diggings in the detritus and rubbish collected at the foot of the above-mentioned mines, and in the alluvial-soil, consisting of the detritus of the rocks, and extending from the foot of the mountain a mile or two down to the plain. The finest Turquoises are at present found in the Khâkî mines, *in fact, good stones for rings are at present only obtained from the Khakî.* Work here is carried on by promiscuous diggings, without any system whatever. The earth is brought to the surface, sifted, and searched for Turquoises, generally by children.

The Turquoises are divided at the mines into three classes, namely:—

1. *Angushtarî* (ring-stones), including all stones of good and fast colour, and of convenient shape. Deep sky-blue is the colour most prized. The best stones of this class are found in the Khâkî diggings and in the Abdurrezzâgî mine.

2. *Bârkânah* stones, of which four qualities are recognized. Only the best of these are sent to Europe, the rest being kept in Persia for encrusting ornamental objects.

3. *Arabî* Turquoises, a name applied to bad stones, of pale colour or greenish or spotted. The whitish Turquoises are called *Shîrbumî* or *Shîrfâm*. Large flat pieces used for amulets are known as *tûtâl.*

About 200 men work in the mines and diggings at

Nishâpûr, and 25 or 30 elders of the village (*Rìsh-ì-Safìds*) buy the stones of the workmen, and sell them to merchants and jewellers either at Meshed or at Nishâpûr itself. The stones are now generally cut on emery wheels, and polished first on slabs of fine-grained sandstone and finally on soft leather with Turquoise dust.

The output of the mines and diggings for recent years has been about 25,000 tomans (= £8,300) worth of Turquoises per annum, as valued at the mines. These mines were at one time to be let; but the author, after carefully enquiring into the matter, found that before any proper mining work on a large scale could be commenced, it would be necessary to expend £50,000 or £60,000 in clearing away the accumulated rubbish. Taking into consideration the fact that only a few really fine Turquoises are found, and that the demand for these stones is not large, he failed to see how after payment of rent and interest on the invested capital, the enterprise could be undertaken with reasonable hope of profit.

FOSSIL OR BONE TURQUOISE, &c.

Beside the true Turquoise described in this chapter, there are two other substances often sold for this stone. One of these is *Odontolite*, or *Fossil Turquoise*—the former name having reference to its origin from tooth, the latter to the fossil condition in which the structure occurs. The Odontolite, or bone Turquoise, is, in fact, nothing more than the tooth, or ivory, or bone of the great extinct elephant called the *Mammoth*, whose remains are brought from Siberia, where they have been mostly preserved by having been frozen in the ice. This fossil Turquoise derives its blue colour from the phosphate of iron, or

Vivianite, with which it is impregnated. It is easily distinguished from the mineral or true Turquoise, by emitting an odour when gently heated. It is, also, softer and more opaque than true Turquoise. It differs entirely from the mineral in composition and structure, and it rarely, if ever, loses its colour. The bony structure may be detected under the microscope. Abroad the fossil Turquoise is more esteemed than in England, in consequence of its freedom from outward change, but it is not so valuable as the Rock Turquoise.

The other mineral often mistaken for Turquoise is *Callainite*—a substance which far more closely resembles the true gem than does the Odontolite. It is, however, of a lighter colour, and has not the peculiar optical properties of the Turquoise. The Turquoise has a translucency peculiarly its own, reflecting light from under its surface; it also easily receives a brilliant polish. The Callainite, on the contrary, is a duller stone, not so vivid nor so fine in colour.

Beads and other ornamental objects in a greenish mineral much resembling Turquoise have occasionally been unearthed from the ancient sepulchral monuments with which the land of Brittany abounds. About 30 years ago M. Damour, the eminent French chemist, analysed some specimens from near Lockmariaker, in the Morbihan, and finding them to be a phosphate of alumina, of green colour, indentified them with Pliny's *Callais*, and suggested a revival of the old name. Dana afterwards proposed for this substance the modified Plinian name *Callainite*, but more recent researches have proved its identity with the mineral called by Breithaupt *Variscite*.

Some interesting discoveries of Variscite, in the form

of nodules, have lately been made in Utah, and polished specimens form pretty ornamental stones of a greenish colour.

TRUE TURQUOISE.

Chemical Composition—

Phosphorus pentoxide ...	32·8.
Alumina	40·2.
Water	19·2.
Copper oxide	5·3
Iron and manganese oxides...	2·5.
	100·0.

Hardness	6.
Specific Gravity	2·75
Form	Amorphous

SECTION IV.

SEMI-PRECIOUS STONES.

Of less commercial value than those described in the foregoing pages, but nevertheless many of them very beautiful.

IT is deemed advisable to arrange this large series of Stones in alphabetical order, without expressing any opinion as to their relative values. Many of these Stones were formerly much worn, but at present there is only a slight demand for them. In my opinion however, some of them, especially the Amethyst, will again become fashionable.

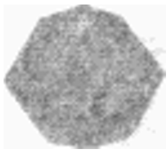
The coloured plates represent several of these stones, shewing their crystalline form, which it is hoped may serve as a guide to those who are interested in the study of gems.

1

2

3

4



5

1. Crystal of Aquamarine
2. C[illegible]
3. Crystal of Amethyst.
4. Crystal of [illegible]
5. Crystal of Tourmaline
6. Crystal of Peridot.

SECTION IV.

SEMI-PRECIOUS STONES.

[illegible]

It is deemed advisable to arrange this [illegible] series of Stones in alphabetical order, without expressing any opinion as to their relative values. Many of these Stones were formerly much [illegible] but at present there is only a slight demand for them. In my opinion however some of them, especially the Amethyst, will again become fashionable.

The coloured plate [illegible] represent several of these [illegible] shewn in their crystalline form, which I hope may serve as a guide to those who are interested in these [illegible] gems.

1. Crystal of Aquamarine.
2. Crystal of Quartz.
3. Crystal of Amethyst.
4. Crystal of Garnet.
5. Crystal of Tourmaline.
6. Crystal of Peridot.

CHAPTER I.

THE AGATE.

BY the term Agate, the mineralogist understands a composite substance, an association of certain siliceous or quartz-like minerals, which in texture, colour, and transparency are diverse one from another. These Agate-forming minerals are chiefly Chalcedony, Carnelian, Jasper and Quartz. Two or more of these, forming a variegated stone, and usually presenting a diversity of spots and stripes, may be denominated an *Agate*. The name is derived from the river Achates, in Sicily, now known as the Drillo, in the Val de Noto, wherein, according to Theophrastus, the ancient Agates were found, in his time.

The Agate is occasionally found in veins, as in certain localities in Saxony and Bohemia, but, as a rule, it occurs in the form of nodules embedded in an amygdaloidal rock, more or less akin to basalt.

On the decomposition of the amygdaloidal agate-bearing rock, the enclosed Agates, by reason of their resistance to the disintegrating effects of weather, remain behind as nodules; hence Agates are frequently found loose in the beds of rivers. The "Scotch pebbles" are Agates which have been liberated by decomposition of their matrix of porphyrite, and are found scattered over the surface of the ground.

Various theories have been propounded from time to time, for the purpose of explaining the origin of the Agate nodules in the cavities of the rocks wherein they occur. The cavities themselves have unquestionably resulted from the imprisonment of gas bubbles, whilst the rock was in a molten condition. The agate-bearing rock is, in most cases, an ancient lava. The nodules of Agate are considered to result from the crystallization, or non-crystalline deposition, of silica, from a solution with which the cavity of the nodule or geode became filled. The silica—now in one condition, such as Jasper, now in another, such as Chalcedony, and then again in the crystallized form of Quartz—was deposited over the irregular inner surface, giving rise to those concentric markings which are seen on the sections of most Agates. This deposition of silica would continue until the geode became filled so as to form a solid Agate, or the inlets of infiltration became stopped up, or the supply of siliceous solution failed. In other cases the silica would be deposited on the walls of the cavity in concentric layers, while, after a time, owing to some change in the natural conditions, the silica might be deposited in layers on the floor of the cavity, in obedience to gravitation, and the various coloured bands would then run parallel to each other in horizontal layers.

According to certain fancied similitudes, which the Agate stone displays to things in common use, it receives distinguishing names. Thus *Riband Agate* exhibits strata or layers of different colours which play one into the other. If the stripes of varied hues are arranged round the centre, it receives the name of *Circular Agate*; and if in this centre there are other coloured points, it is called *Eye Agate*. When the variously coloured bands are disposed in an angular pattern, suggestive of the plan of a polygonal

fortress, it is called *Fortification Agate. Moss Agates* enclose green and brown mineral matter suggestive of vegetable growth, whilst *Mocha Stones* contain dendritic or branching markings of brown colour, due to oxide of manganese and perhaps iron.

In speaking of *Oriental* and *Occidental Agate*, we conventionally understand that all the most beautiful and translucent sorts belong to the Oriental, and the less valuable to the western variety.

Although very fine Agates are found in India, our supply is derived in large part from South America, though many other parts of the world also yield these stones. In the bed of the Rio Pardo, the Taquarie, and other rivers in Uruguay, Agate nodules are found in considerable quantities and often of large size. These are generally known as "Brazilian Agates," and are largely exported to the polishing mills of Germany. These mills, which are mostly carried on in the most primitive manner, are situated mainly in the neighbourhood of Oberstein, on the Nahe, a tributary to the Rhine at Bingen. The location of the Agate industry in this district was originally determined by the occurrence of Agates in the melaphyre rocks of the Galgenberg, where they were worked more than four centuries ago. The quarries, or rather mines—for the Agate rock was worked in subterranean tunnels—have been abandoned since the discovery of the Agate in Uruguay; but the work of cutting and polishing the stone is still carried on largely in the neighbouring villages.

In a district of $8\frac{3}{4}$ square miles, stand the two little towns of Oberstein and Idar, the chief centres of the Agate industry. Not only is a great proportion of the inhabitants of these towns in some way occupied in cutting, polishing, and colouring these stones, but for miles round

every valley is dotted with the homes of those who follow this business. Agate polishing has also been carried on of late years at Waldkirch in Baden.

In 1770 there were only 26 cutting and polishing mills in Birkenfield, whereas in 1870 there were 180. In each mill there are four or five grindstones. These are of red sandstone, obtained from Zweibrücken; and two men ordinarily work together at the same stone. The Agate is usually cleaved to the requisite form by means of the hammer, a work which exacts much skill from the artisan: for he must be well acquainted with the natural grain of the Agate, since there is no true cleavage to guide him.

One of the most interesting branches of the Agate industry is that of colouring the stones by artificial means. This subject has already been dealt with on pp. 48—51.

In the amygdaloidal rocks of Perthshire, Forfarshire, and other parts of Scotland, Agates of very pleasing patterns are found. These are cut and polished under the name of "Scotch Pebbles," and are employed as ornamental stones in common jewellery.

AGATE.

Chemical Composition	Silica.
Hardness	7.
Specific Gravity	2·6.
Form	Amorphous, and nodular.

CHAPTER II.

AMAZONITE.

A BEAUTIFUL green mineral is occasionally used as an ornamental stone under the name of *Amazonite* or *Amazon Stone*. Formerly it was nearly all derived from Siberia, but in recent years magnificent examples have been found at Pike's Peak, Colorado ; while it has also been discovered in Scotland.

Amazon-stone is a bluish-green felspar, formerly regarded as a variety of orthoclase, but placed by the late M. Descloizeaux, on account of its optical behaviour, with *microcline*. Its colour has been referred to the presence of oxide of copper, but according to König, it is due to an organic compound of iron.

AMAZONITE.

Composition—	Silica	65.
	Alumina	18.
	Potash	13.
	Soda, &c.	4.
		100.
Hardness		6·0.
Specific Gravity		2·5.
Crystalline System		Triclinic.
Form		Various prismatic combinations.

CHAPTER III.

AMBER.

AMBER is a fossil resin, and its external condition, as well as its chemical composition, points to its vegetable origin. This view is strengthened by its frequent occurrence in connection with brown coal or lignite.

If further proof were wanted of the vegetable origin of Amber, it exists in the inclusion of insects, leaves, pieces of wood, moss, seeds, and little stones, all of which may be seen in that which is found on the coast of the Baltic, or in Burma. The condition of these inclusions proves the liquid character of the resinous matter as it flowed forth and involved the insects; and it shews, also, the subsequent slow progress of the solidification which ensued. The most delicate parts of the creature are often preserved in their natural positions—probably because the Amber, when it originally exuded from the tree, was a liquid of thin consistency.

The innumerable organic remains, which this resin has preserved uninjured for ages, give us a marvellous insight into the vegetable life of that division of the Tertiary period known to the geologists as the Oligocene age—the age to which the Amber forests of northern Europe may be referred. We here see plants quite unknown at the present day in the flora of the northern sea-coasts, but which have a relationship to the existing flora of the shores of the Mediterranean. The late Prof. Goeppert, of Breslau, christened the principal Amber-yielding tree the *Pinites succinifer*.

Amber is non-crystalline, translucent, and somewhat brittle; it has a specific gravity as nearly as possible the same as that of sea-water. Its fundamental colour is yellow in all shades, running on one side into white and hyacinth red, and on the other into brown and black. The green and blue specimens are never pure.

It becomes electrical by friction, and this property was familiar to the Greeks as far back as the days of Thales of Miletus, who observed that when rubbed it acquired the property of attracting light substances. The word Electricity is, in fact, derived from the Greek word *electron*, signifying *Amber.*

Chemically, Amber is composed of a volatile oil, several resins, and succinic acid. The principal resin of Amber is known as *Succinite*—a name often applied by mineralogists to Amber itself. The Sicilian Amber, of rather different composition, is termed *Simetite*, after the River Simeto where it is found.

Wherever Amber is found, whether in France, Holland, Sweden, Italy, Sicily, Spain, Siberia, China or India, it is in association with brown-coal or lignite. The most prolific fields of Amber are the great plains of northern Germany, and the coasts of the Baltic, especially between Königsberg and Memel, where it occurs in a loose clayey sandstone, which, from its colour, is known as "blue earth." At Palmicken, in Samland, in eastern Prussia, the Amber is systematically worked by subterranean mining; but in most places the Amber gatherers simply dig it from the soil, or pick it from the cliffs, or collect the nodules that are cast by the waves upon the shore.

Specimens of Amber, in the form of rolled nodules, are occasionally found washed ashore in this country, especially on the coast of Norfolk, near Cromer.

Large quantities of Prussian Amber are sent to Breslau, Odessa, and Constantinople. Amber forms an important industry not only in Dantzic, Königsberg, Stolpe, and Lübeck, but in Vienna, Constantinople, and Catania, in Sicily. It is notable that the Sicilian Amber possesses a peculiar opalescence, or even *fluorescence*—presenting a difference of tint according as it is viewed by transmitted or by reflected light.

Necklaces and bracelets of Amber are sent to Egypt and India, and the meanest Turk seeks a piece of it for his pipe, not only because it is pleasant to the lip, but because he has a belief that it will preserve him from inhaling pestilence.

Amber is very fashionable for cigarette cases, match and stamp boxes, and other objects set with gems, which make extremely beautiful presents. It is almost impossible to obtain pieces of Amber large enough for ladies' card-cases or gentlemen's cigar cases.

Amber was much valued by the Ancients, and we find it mentioned as early as the time of Ezekiel (Ez. c. i., v. 4). It was particularly prized by the Romans. From the second Imperial epoch down to the middle of the fourteenth century, Amber was cut into knives and one-pronged forks, which the princes and great church dignitaries used for cutting up various kinds of fruits and vegetables, especially their esculent fungoids—mushrooms, and the like. It was, and still is, more valuable than gold. The Greeks very early received from the Phœnicians chains made of Amber, both for the neck and arms, and it is mentioned in connection with heathen mythology from very ancient times.

According to the legend, the sisters of Phæton, mourning and weeping at his unhappy end, attracted the

pity of the gods, who mercifully changed them into trees, and their tears still flowing on, became Amber. A yet stranger origin is given to this fossil, in the well-known couplet of the fire-worshippers—" Around thee shall glisten the loveliest Amber, that ever the sorrowing sea bird hath wept."

The great value set upon Amber, even in pre-historic times, is seen in the care with which objects of this material were interred with their possessors in tumuli or burial-mounds of very early date. The finest archaic specimen in this country is an Amber cup in the Brighton Museum, originally found with bronze and stone weapons in a barrow at Hove.

AMBER.

Composition ...	Carbon, Hydrogen, and Oxygen
Specific Gravity	... ... 1·08.
Hardness ...	... ... 2·5.
Form	Amorphous ; occurring as nodules.

CHAPTER IV.

AMETHYST.

THIS term is now applied to all the violet and purple crystals of Quartz, which, when fractured, present the peculiar rippled or undulated structure described by Sir David Brewster. The stone called *Oriental Amethyst*, is strictly a variety of Sapphire, of violet colour, but the term is applied commercially to any Amethyst of exceptional beauty.

Amethyst is a variety of Quartz said to contain traces of oxide of manganese, to which the violet colour is commonly attributed. When heated, however, it becomes yellow or white, and may acquire opalesence. The crystals, like those of quartz in any other of its manifold varieties, are of sufficient hardness to scratch glass, and are infusible before the blow-pipe.

The Amethyst is dichroic, or exhibits under certain conditions two distinct tints—the one being reddish purple and the other bluish purple.

Amethysts are usually found in association with Agates. Brazil, Uruguay, and Siberia furnish us with the best specimens of the dark coloured stones. The common Amethyst is found in nearly all parts of the world, but is of very little value.

To show the fall in the value of this stone, we may refer to the Amethyst necklace of Queen Charlotte, which was supplied by my predecessors, Messrs. Emanuel Bros., of Bevis Marks. It consisted of well-matched and very

perfect stones, although only of the common variety, and was valued at £2,000; but it is doubtful whether, apart from its historical associations, it would now realise £100. I think, however, that the Amethyst will again come into favour, and probably the Americans may be the means of reviving its popularity, just as they have made Opals fashionable.

Cameos and intaglios of very ancient date, and in every style are met with in Amethysts. As a rule, stones of a pale colour are used for engraving rather than the dark; yet the late Rev. C. W. King says he has seen perhaps the grandest Greek portrait in existence, a head of Mithridates, cut in a large Amethyst of the deepest violet colour, which was found a century ago in India. There was another very ancient intaglio of the head of Pan in the Uzielli collection. One of the largest Amethyst cameos was the gem, representing a bust of Trajan, taken from the Prussian treasury during the Napoleonic wars.

It may be added that the word "Amethyst," though probably of Oriental origin, is usually regarded as derived from the Greek privative *a* and the verb *methuo*, "to intoxicate"—whence the old notion that this stone was an antidote to drink, a charm against intoxication.

AMETHYST.

Composition :—

Silica, coloured probably by oxide of manganese.

Specific Gravity	2·6
Hardness	7.
System of Crystallization	Hexagonal.
Form of Crystals	Generally six-sided pyramids and prisms.

CHAPTER V.

ANDALUSITE.

THIS mineral, which was named from its occurrence in the province of Andalusia, in Spain, is occasionally found in Brazil in clear crystals admitting of being cut as an ornamental stone, Andalusite is, however, a very rare gem-stone. It is remarkable for displaying marked pleochroism. Some of the green crystals shew in the dichroiscope green and yellow images, whilst the brown crystals give a reddish brown and greenish yellow. A remarkably fine specimen of rich colour and great brilliancy, weighing 17½ carats, was recently in the author's possession. Although a beautiful stone its hardness is only slightly above that of quartz.

ANDALUSITE.

Chemical Composition :—

Silica	36·9
Alumina	63·1
	100·0

Specific Gravity	3·1
Hardness	7 to 7·5
Crystalline System	Orthorhombic.
Form	Prismatic Crystals.

CHAPTER VI.

AQUAMARINE, OR BERYL.

AQUAMARINE is a name given to the varieties of Beryl which possess a pale green colour suggestive of sea-water, whence the name *aqua marina*. In fact, the Beryl, the Aquamarine, and the Emerald—though differing much in value as gem-stones—are all united by mineralogists under the head of a single species, inasmuch as they are found to agree in crystallographic and chemical characters, while they differ mainly in colour. The pale green of the Aquamarine is probably due to the presence of a small proportion of oxide of iron, whereas the rich green of the Emerald appears referable to oxide of chromium

Aquamarine comes to us from Brazil; and it is also found in the Ural Mountains, the Altai Mountains, in Siberia, Australia, and other parts of the world.

Aquamarine is made into a variety of ornaments. It is said that the Emperor Commodus possessed an Aquamarine engraved with a portrait of Hercules by Hyllus; and that in the treasures of Odescalchi, there was a stone engraved by Quintilius. representing Neptune, drawn by sea-horses, In the National Library in Paris there is a beautiful engraving by Evodus, on Aquamarine, of the head of Julia, the daughter of Titus. An Aquamarine, $2\frac{1}{16}$ inches long and $2\frac{2}{3}$ in thickness, adorned the tiara of Pope Julius II.

One of the finest known specimens of Aquamarine is the remarkable sword-hilt which was in the collection of

the late Mr. Beresford Hope, exhibited for some years in the South Kensington Museum. It is covered with facets, and is unique both as a mineral and as an example of the lapidary's art This stone, which is said to have belonged to Prince Murat, weighs 3½ ozs. There were also in Mr. Hope's collection some fine engraved Beryls.

AQUAMARINE.

Composition—	Silica	66·8
	Alumina	19·1
	Glucina	14·1
		100·0
Specific Gravity		2·7
Hardness		7·5
System of Crystallization		Hexagonal.
Forms of Crystals		Six-sided prisms.

CHAPTER VII.

AVANTURINE.

IT is related that a French glass maker, happening to let some brass filings fall into his glass-pot, was surprised to find that the product presented a beautifully-spangled appearance. To this gold-spotted glass the name of *Avanturine* was given. because it had thus been formed *par aventure*—"by accident." The name was afterwards applied to a mineral which presents an appearance somewhat like that of the avanturine glass

This mineral, though rare, is nothing more than a translucent variety of Quartz, generally of brownish-red but sometimes of green colour, and having disseminated throughout its mass a vast number of glittering points which appear generally to be minute scales of Mica. It is used to a limited extent as an ornamental stone.

AVANTURINE.

Composition—Silica, with oxide of iron, alumina, and other impurities.

Specific Gravity	2·6
Hardness	7·
Form	Massive and schistose.

CHAPTER VIII.

BLOODSTONE.

BLOODSTONE, or *Heliotrope*, is a variety of Chalcedony, of a deep green colour, interspersed with red spots of Jasper, which resemble small drops of blood, whence its name.

Although a beautiful mineral, it is not much used for ornamental purposes, except for signet rings. Being a rather hard stone, yet not difficult of manipulation, it is a favourite with engravers, and hence crests and monograms are frequently engraved upon it. Cups, boxes and other ornamental objects of small size, are also fashioned from it. It was much prized by the ancient Egyptians and Babylonians, who employed it for seals, intaglios, &c.

In the Royal Collection in Paris is a bust of our Lord Jesus Christ in Bloodstone, so executed that the red spots of the stone stand out like real drops of blood.

BLOODSTONE.

Composition—Silica, with a small percentage of peroxide of iron.

Specific Gravity	2·6
Hardness	7
Form	Amorphous.

CHAPTER IX.

CARNELIAN.

CARNELIAN is nothing more than a pale-red variety of *Chalcedony*, itself a form of Quartz, characterized by its translucency, or semi-opacity, and by an absence of distinct crystalline texture. The word *Carnelian* is said to be derived from the Latin word *Caro*, "flesh," in allusion to the reddish colour of the stone. As to the word *Chalcedony*, some believe it to be derived from *Chalcedon*, now Kadi-Kene, an ancient city in Bithynia, the place where it was earliest found. The Ancients called the Carnelian *Sarda*, either from the town of Sardis in Asia Minor, or from the Arabian word "Sard" (*yellow*).

Carnelian is chiefly found in nodular masses, and in the interior of Agates. Its colour varies from blood-red to wax-yellow, and reddish-brown; it is cloudy, seldom striated, semi-transparent, and of waxy lustre. By heat the colour of Carnelian becomes intensified, because its colouring matter, which is a hydrated oxide of iron, or ferric hydrate, becomes dehydrated, or loses more or less of its water, and is thus reduced partially or completely to the state of anhydrous oxide of iron, or ferric oxide, the colour of which is bright red. By an over application of heat it sometimes loses its colour and becomes white, pale, and friable.

Carnelian of a light ruby colour is of more value than the other varieties of Chalcedony; the pale-red ranks next.

At Oberstein and Idar ordinary pale-grey Chalcedony is coloured red by chemical means, and thus converted into a brightly tinted Carnelian.

This stone appears to have been chosen by the Greeks and Romans for cameos and intaglios in consequence of its possessing a beautiful colour and a certain hardness, affording a facility for manipulation. The oldest Greek gems known are in the collection of the Emperor of Germany. One of them is a Carnelian, on which is represented a winged Jupiter appearing to Semele; and the other an opaque Sardonyx, on which is engraved a draped figure of Venus. There is a Carnelian of the earliest period in the St. Petersburgh collection, on which a man's head is engraved, with most artistically arranged beard. The British Museum possesses an example of the second period, viz., a Carnelian butterfly, carrying a representation of Venus, of very fine workmanship.

A Carnelian of the third period is in the Royal Collection of Vienna, and represents Helena. On a small Carnelian, in the Collection at Florence, there is a head of Apollo, adorned with laurels and fillets. In the Berlin Museum there is an unique Indian Carnelian, almost as transparent as the Hyacinth, engraved with the head of Sextus Pompeius. One of the most famous of the ancient deep-cut stones represents the birthday festival of Dionysius, and was once, it is said, possessed by Michael Angelo.

CARNELIAN.

Composition—Silica, with oxide of iron.	
Specific Gravity	2·6
Hardness	7
Form	Amorphous.

CHAPTER X.

CHRYSOBERYL.

THE ORIENTAL CHRYSOLITE OF LAPIDARIES.

THERE is probably no stone the composition of which has been given with so much variation as this. There is, however, reason to believe that chemists have frequently analysed different stones, and confounded them under one term. The true Chrysoberyl, as known to us to-day, is essentially a compound of alumina and glucina, with varying proportions of oxide of iron. There are three varieties of this stone—the *Chrysoberyl*, the *Cymophane* or *true Oriental Cat's Eye*, and the *Alexandrite*. The colours of the Chrysoberyl range from light asparagus green, golden yellow, brownish yellow, and golden brown, to columbine red.

The crystalline forms of the Chrysoberyl belong to the rhombic system. It is usually found as rolled pebbles in the same sands as those which furnish crystals of Topaz and Corundum. Crystals of great beauty are found in the Emerald mines of Takowaia, east of the Catherine Mountains in the Ural. It is brittle, transparent, or translucent, and possesses in a high degree the power of double refraction, and a vitreous and oily lustre. A peculiar bluish opalesence, in the inner part of the stone, is sometimes seen.

It is interesting to trace the history of our knowledge of the chemical constitution of Chrysoberyl. Klaproth

and Arfwedson considered it to be composed of silicic acid and alumina. To Seybert we are indebted for the discovery of glucina in it. He believed it was composed of silicic acid, alumina, and an aluminate of glucinum or beryllium. Thomson declared that he could find no silicic acid in it, and was confirmed in this view by Rose.

Asparagus or yellow-green Chrysoberyl was known in very early times to the people of Ceylon and Brazil. In Ceylon it is found in river sands in company with Tourmaline, Spinel, and Sapphire. In Borneo, and in Burma, it is found amongst pebbles and loose alluvia. In Brazil, pieces of the Chrysoberyl of the size of a hazel nut, and of yellowish-green colour, are sometimes met with while washing for Diamonds. Of late years it has also been found in granite in Connecticut, North America, in well-formed tables and prisms, with Tourmaline, Garnet, and Beryl; and at Saratoga and Greenfield in New York State, in regular twin crystals with Tourmaline, Garnet, and Apatite.

CHRYSOBERYL.

Composition—	Alumina	...	78
	Glucina	...	18
	Ferrous oxide	...	4
			100

Specific Gravity ... ... 3·5 to 3·8

Hardness ... ... 8·5

Crystalline System Trimetric or ortho-rhombic.

Form Flat prisms; generally as rolled pebbles.

CHAPTER XI.

CHRYSOPRASE.

THE Chrysoprase is mentioned in the book of Ezekiel (c. xxvii., v. 16), and it is also referred to as one of the stones in the wall of the Holy City (Rev., c. xxi., v. 20). It has been said, however, that the Chrysoprase of the Ancients was a very different stone from that which is known by this name at the present day. Pliny speaks of it as a well-known gem, and tells us that vessels were made of it, and that the stone was obtained from India in great quantities. No antique works in true Chrysoprase have come down to us. The costly mosaic walls of St. Wenzel's Chapel, in the Cathedral of St. Beit at Prague, built in the 14th century, contain splendid specimens of Chrysoprase.

Our Chrysoprase is a green variety of Chalcedony, of extremely local occurrence. It is found in Silesia, near Kosemütz, Gläsendorf, and Baumgarten, not far from Frankenstein. It occurs in veins of serpentine, in company with other siliceous minerals, such as Quartz, Chalcedony, and Opal.

Among the semi-Precious Stones, the Chrysoprase deserves to be one of the greatest favourites. It possesses a beautiful apple-green colour of many shades, and a transparency and capability of high polish, together with the advantage of being found in large pieces. Exposure to sunlight, however, renders it liable to fade slightly. It was the chemist, Klaproth, who discovered the presence of nickel,

and that the stone contained a small quantity of water. The nickel oxide is therefore, probably united with water, as hydrate, in the Chrysoprase, and if by the influence of heat, some of the water in the stone is lost, the beauty of the colour may be more or less destroyed.

At Oberstein a green colour is imparted to ordinary Chalcedony, by means of salts of nickel or of chromic acid so as to produce an artificially tinted Chrysoprase.

CHRYSOPRASE.

Composition—	Silica	97·5
	Oxide of Nickel, &c. ...	2·5
		100·0
Specific Gravity	... ...	2·6
Hardness	... ...	7
Form	... ...	Amorphous

CHAPTER XII.

CROCIDOLITE.

WITHIN the last quarter of a century a great deal of this mineral has been brought from South Africa, and introduced into commerce as *Cat's Eye*; but whilst the true Oriental Cat's Eye is a valuable and beautiful gem, this stone is comparatively worthless for jewellery. It is, in fact, mainly a ferruginous Quartz, or Chalcedony, associated with a fibrous mineral known as true Crocidolite, or a pseudomorph after it.

Crocidolite is a mineral belonging to the group of Hornblendes, and consists of thin delicate silken fibres compacted together in masses, and often associated with magnetite or magnetic oxide of iron.

When Crocidolite is cut *en cabochon*, it exhibits, in some degree, the Cat's Eye effect; it being an optical property of all acicular or fibrous minerals, when cut with a curved surface, to show more or less chatoyancy on a line at right angles to the fibres of the substance.

The colours of the Crocidolite are usually some shade of yellow, with a ray of a lighter colour; or rich brown deepening to almost black; or a dark indigo with a zone of lighter blue. The brown variety is known as *Tiger's Eye* and the blue as *Hawk's Eye*.

The so-called Crocidolite Cat's Eye comes principally from a locality on the Orange River in Griqualand West,

but is also found in other parts of South Africa. It has been regarded as mainly a pseudomorph of quartz or chalcedony after true Crocidolite—in other words, the original material has been converted into a quartzose substance while retaining its fibrous form. It seems, however, that some at least of the so-called Crocidolite used as an ornamental stone is a mixture of Crocidolite and Chalcedony, with much oxide of iron. The mineral has been studied microscopically and chemically by Fischer, Wibel, Renard, Klement and others.

CROCIDOLITE.

Chemical Composition:—

Silica	51
Oxide of Iron... ...	34
Soda	7
Magnesia	3
Water	5
	100.

Specimens vary very much in composition, and some of the South African mineral is mainly Chalcedony.

Specific Gravity ... About 3.
Hardness ... ... Nearly 7.
Form ... ... Fibrous masses in veins.

CHAPTER XIII.

EUCLASE.

THIS mineral has occasionally been cut and polished as a gem-stone, but rather as a matter of scientific curiosity, than with a view to its introduction into jewellery. It is, in fact, a rare mineral, occasionally found with Topaz at Villa Rica, in Brazil. It is also known to occur with Beryl, on the River Sanarka, in the Urals.

Euclase is always found in crystals which exhibit perfect cleavage, and perhaps the most curious feature of the stone is its excessive brittleness—whence, indeed, the name "Euclase," from *eu* and *klao.* Its colour is generally a pale straw, passing in some specimens into blue and green. The mineral is trichroic, and possesses considerable lustre. In its chemical relations it stands closely related to the Emerald.

EUCLASE.

Chemical Composition:

Silica	41·20
Alumina	35·22
Glucina	17·39
Water	6·19
	100·00

Specific Gravity	3
Hardness	7·5
Crystalline Form	Trimetric.
Form	Prismatic crystals.

CHAPTER XIV.

THE GARNET, CARBUNCLE, AND CINNAMON STONE.

UNDER the general name of Garnet, the mineralogist includes a number of stones which present a great variety of colour, ranging from the lightest cinnamon, through all shades of red and crimson, and even to various tints of green. Between these diverse minerals the chief bonds of association are to be found in their crystallographic relations, and their constancy of chemical type. On glancing at the various analyses of different Garnets, one might fail to recognize their relationship; but the chemist is aware that these changes of composition take place according to certain definite laws, without violating the general type on which they are constructed. Their specific gravity, and even their hardness, are subject to great variations, corresponding to their differences of composition. They all belong to the isometric or cubic system, and are consequently monochroic.

The Garnet was a great favourite with the Ancients, and antique Garnets have often been found in Roman ruins. In former days it was very frequently engraved, and beautiful specimens are now to be seen in Paris, Turin, Rome, and St. Petersburg. The small degree of hardness possessed by this stone renders engraving on it comparatively easy.

The word Garnet probably owes its origin to the similarity of the colour of this stone to that of the blossom

and kernel of the pomegranate, a fruit of Southern Europe. It is not a name of ancient date. Pliny calls it "Carbunculus," from *Carbo*, a live coal. According to some authorities, however, it is thought that the origin of the word Garnet is to be found in *Granum*, "a grain," because it is so often found in granular forms. The Precious Garnet is sometimes called "Almandine," from the city of Alabanda, in Caria. Its colour is blood-red, cherry-red, or brownish-red: by candle-light it assumes a violet tint.

Garnet is almost world-wide in its distribution.

A new variety of Garnet, closely resembling the Burmese Ruby in colour, was found a few years ago under very difficult circumstances, in the interior of New Mexico. Lapidaries were at first unable to determine, by mere cutting. the nature of this stone. A specimen was accordingly sent to Sir W. Crookes, F.R.S., who, by analysis found that it contained as much as 42 per cent. of Alumina.

Fine Garnets have been found abundantly in the MacDonnel Ranges in the interior of South Australia, and have been sometimes termed "Australian Rubies."

The principal varieties recognised by mineralogists are the *Almandine*, or Precious Garnet; the *Essonite*, or "Jacinth" and "Hyacinth;" the *Pyrope*, or Bohemian blood-red Garnet, the *Uwarowite*, or chrome Garnet and the *Demantoid*, or green Garnet. Each of these will now be separately described.

ALMANDINE (*Carbuncle*).

The Almandine is a beautiful stone of rich claret colour, and is the most esteemed of the whole family of Garnets. It is the stone which is generally employed for Carbuncles. The difference between a Carbuncle and a

Garnet is simply that the former is cut *en cabochon*, whilst the latter is generally cut with a table and facets.

Almandine Garnet is occasionally found to be asteriated, but such specimens are rare.

ALMANDINE (Carbuncle).

Chemical Composition :—

Silica	36·5
Alumina	21·0
Iron protoxide	34·5
Magnesia	4·0
Lime	3·0
Manganese protoxide ...	1·0
	100·0

Specific Gravity ... ...3·5 to 4·3
Hardness ... ... about 7
Crystalline System ... ... Cubic.
Forms ... Rhombic dodecahedron and 24-faced trapezohedron.

PYROPE.

The Pyrope, sometimes known as "Bohemian Garnet," is of a blood-red colour, never purple. When cut like a brilliant it is very bright, but owing to its occurring in small pieces, it is more usually rose-cut and mounted *en pavé.* It is found principally in Saxony and Bohemia, where it occurs embedded in Serpentine. By the gradual decomposition of this matrix, the Garnets are set free and being carried down by streams, are found in the sands of the rivers, where they are collected by children. Fine

Pyropes occur with the Diamonds of South Africa, and are unfortunately termed "Cape Rubies;" but some of these may be Almandine.

PYROPE.

Chemical Composition :—

Silica	41·5
Alumina	22·0
Magnesia	15·0
Iron protoxide	9·5
Lime	5·0
Chromium sesquioxide ...	4·5
Manganese protoxide ...	2·5
	100·0

Specific Gravity ... ... 3·7 to 3·8
Hardness ... ... 7·5
Crystalline System ... ... Cubic.
Forms... ... Same as those of Almandine.

ESSONITE.

This stone, which comes principally from Ceylon, passes under three names according to its colour. The lightest of the three is of a pale cinnamon colour, and is hence known as *Cinnamon Stone.* The next is a little darker, with a peculiar admixture of red and orange, and is known to jewellers as *Jacinth.* The last has a darker shade of bright red, orange and brown, giving rise to the peculiar hyacinthine tint, and it is therefore called in trade a *Hyacinth.* It is a common error to confound these hyacinthine Garnets with Zircons of similar colour, to which the names Jacinth and Hyacinth are also applied.

A Garnet resembling Essonite in composition, but of green colour, is known as *Grossularia*, or "Gooseberry Stone." It is found chiefly in Siberia.

ESSONITE.

Chemical Composition:—

Silica	40
Alumina	23
Lime	32
Iron protoxide, &c.	5
	100

Specific Gravity	3·4 to 3·7
Hardness	7
System	Cubic.
Forms ...	Same as those of Almandine.

UWAROWITE and DEMANTOID.

Of the many other varieties of Garnet, more or less rare, occurring in a state of perfection fit for jewellery purposes, mention may be made of the mineral called *Uwarowite.* It presents a fine Emerald-green colour, and when sufficiently clear and large forms a beautiful and lasting stone. It is very little used in jewellery, and is often confounded with the "Green-Garnet" (Demantoid) of the Urals, which is a much softer stone, but one which exhibits a great amount of "fire," especially by artificial light. This latter stone has only been known within the last few years; it is a silicate of iron and lime. It was found first in the gold-washings of Nischne Tagilsk, and afterwards in those of the Bobrowska, a stream which flows into the river Tschussowaia, in the Ural Mountains. By

mineralogists it has been termed *Demantoid,* and by Russian jewellers it is often called "Siberian Chrysolite," or Olivine. I am sorry to say it has been sold in England as Olivine, at as high a price as £5 per carat.

UWAROWITE.

Chemical Composition :—

Silica	37
Lime	33
Chromium oxide	23
Alumina	7
	100

Hardness	7·5 to 8
Specific Gravity	3·5
Crystalline System	Isometric or Cubic.
Forms	Rhombic dodecahedra and 24-faced trapezohedra.

CHAPTER XV.

HÆMATITE.

THERE are certain ores of iron which are used to a limited extent in jewellery and in the Fine Arts—notably *Hæmatite*, a mineral which has been used from time immemorial for intaglios, and occasionally for the imitation of black Pearls. Although of steel-grey colour when polished, the streak of the mineral, when scratched, is of a reddish-brown or cherry-red colour, whence the word *Hæmatite*, meaning "blood-stone," is derived.

The occurrence of Hæmatite is wide-spread, but the hard variety which is polished as an ornamental stone, is found chiefly in the Carboniferous Limestone of Cumberland, especially near Whitehaven. Crystals, when found have often a highly splendent lustre, and are hence known as "Specular Iron-ore." Usually, however, the Hæmatite occurs in reniform or kidney-shaped masses, whence it is often called "kidney-ore."

HÆMATITE.

Composition—Peroxide of Iron, containing—

Iron	70
Oxygen...	30
	100

Specific Gravity	4·5 to 5·3
Hardness	5·5 to 6·5
System	Rhombohedral.

Forms—Complex modifications of Rhombohedra; but generally reniform and massive.

CHAPTER XVI.

HIDDENITE.

HIDDENITE is a very rare and comparatively little-known gem-stone, which was discovered in 1880 in Alexander County, North Carolina, by Mr. W. E. Hidden, after whom it was named. In appearance it is something like the Emerald, both in its rough and cut states. It is of a brilliant green hue, lighter than that of the Emerald, verging towards yellow, and possessing a beauty of its own. Hiddenite is a variety of the mineral called *Spodumene* or *Triphane*, and is sometimes termed "Lithia Emerald." It occurs in association with Emeralds, and the two gem-stones have been worked by "The Emerald and Hiddenite Mining Company." A station on the Taylorsville extension of the Western North Carolina Railroad, near the mine, is named "Hiddenite."

HIDDENITE.

Composition—A silicate of Aluminium and Lithium.

Specific Gravity	3
Hardness	7
Crystalline System	Monoclinic

CHAPTER XVII.

IOLITE.

UNDER the name of *Iolite* or *Dichroite* the mineralogist is familiar with a certain stone which is remarkable for its pleochroism, ro differences of tint when viewed in different directions. Occasionally it is cut and polished as a gem-stone, and is known to the jeweller as *Saphir d'eau.* The best specimens come from Ceylon, those from Bavaria being almost opaque. It is also found at Haddam, Connecticut. The usual colours are various shades of blue and violet, whence the name "Iolite." The dark blue Iolite is sometimes known as *Lynx-sapphire*, but this term is also occasionally applied to an indigo-blue variety of true sapphire.

IOLITE.

Chemical Composition.

Silica	49
Alumina	34
Magnesia	9
Ferrous oxide	8
	100.

System of Crystallization	Trimetric
Specific Gravity	2·6
Hardness	7
Form	Prismatic crystals, or as pebbles.

CHAPTER XVIII.

JADE.

TRUE Jade is known to mineralogists as *Nephrite* or "kidney-stone," in consequence of its former use in diseases of that organ. It is a compact variety of hornblende, consisting of a silicate of magnesium and calcium. Much of the mineral known as Jade was separated from Nephrite, many years ago by M. Damour, and regarded as a distinct species under the name of *Jadeite*. This is a silicate of aluminium and sodium, and seems to be a form of acmite. The specific gravity of Jadeite is above 3, and may be as high as 3·3, while that of true Jade is generally below 3, and never exceeds 3·18.

The Chinese have for ages worked this stone into most elaborate and delicate forms, and prized it as one of the choicest products of the mineral kingdom. Most of the Chinese Jade is obtained from the quarries of Upper Burma. Jade was also used by the Maories, or natives of New Zealand, chiefly for the grotesque breast ornament known as *tiki*, and for the peculiar club called the ***mere***, or *pattoo-pattoo*. This Jade, called in New Zealand ***punamu***, or "green stone," is also now used for earrings, pendants, charms, and other ornamental objects. Jade is also found

in Siberia, New Caledonia, Turkestan, Burma, Alaska, and a few other localities, but usually in only limited quantity.

Chemical Composition (Green Jade or Nephrite, of New Zealand):—

Silica	57·75
Magnesia	19·86
Lime	14·89
Oxide of iron, alumina, &c. ...	7·50
	100·00

Specific Gravity .. ... 2·91 to 3·18

Hardness ... ... 6·5

Form ... Amorphous: occurring as a rock.

CHAPTER XIX.

JASPER.

BY modern mineralogists the term Jasper is restricted to the opaque varieties of Quartz, which present a compact texture, and are destitute of any crystalline structure. But the Jasper of the Ancients was evidently a different substance, inasmuch as it is usually described as possessing a green colour associated with more or less translucency. The Greek name, *Jaspis*, according to Isodore, "signifieth green, and such a green as doth illustriously shine forth with a very supreme viridity, or greenness of glory." Pliny considers the *Jaspis* to be a gem of a dull green-colour, like an Emerald, but not so transparent. The name itself is very ancient. This gem is said to be the *Jaspeh* or eleventh stone, in the breastplate of the High Priest. The glory of the supposed Jasper is often made use of in the Holy Scriptures to represent the New Jerusalem, but the author believes this to be wrongly translated and to refer really to the Diamond.

Pliny assures us that Eastern nations wore pieces of it as amulets. Even Galen soberly asserts that "the green Jasper benefits the chest and mouth if tied upon it;" and De Boot, writing so late as 1609, does not hesitate to ascribe rare medicinal virtues to the Jasper.

Jasper is commonly found in compact masses or as pebbles. Its colours are brown, yellow, and red of various shades, sometimes green and rarely blue. That known as

Egyptian Jasper is found in rounded masses, in the desert near Cairo; it is of dull yellow colour, deepening into brown, and is usually marked with stripes or zones.

Common Jasper, generally red and brown, but sometimes yellow and black, is found in many localities; for example, in the old rocks of North Wales and in Scotland.

Ribband or Striped Jasper occurs in compact masses with a conchoidal fracture. It has stripes or zones of grey, green, yellow, red, and brown, and is mostly found in Siberia. The so-called *Porcelain Jasper* is only burnt clay.

The Red Jasper was much valued in early times for engraving. In the Vatican there is a beautiful vase of Red Jasper, with white veins, and another of Black Jasper, with yellow veins. In China the Emperor's seal is of Jasper; and in that country the stone is highly valued. In Florence the Yellow Jasper is largely employed for Mosaics, and the Ribband Jasper for cameos.

JASPER.

Chemical Composition :—	
Silica	99·5
Oxide of iron	·5
	100·0
Specific Gravity	2·6
Hardness	7
Form	Amorphous.

CHAPTER XX.

LABRADORITE.

THE Spaniards found amongst the ornaments of the Indians, dwelling upon the shores of the Amazon, grotesque figures formed of this mineral, supposed to have been exhumed from the tombs of the old Peruvians. It is now found principally on the northern coast of Labrador, and was originally sent home by the Moravian missionaries.

From its occurrence in the Peninsula of Labrador, where it forms, by its remarkable brilliancy of colour, the "fire rocks" of the Indians, it is variously known as *Labrador*, *Labradorite*, or *Labrador felspar*. The last name shows that it belongs to the great family of Felspars. It is, indeed, a common constituent of many rocks, but only exceptional specimens are sufficiently beautiful to be used as ornamental stones, and even these have very little value.

Generally speaking, the body-colour is a dull grey, brown, or greenish brown ; but typical specimens of the mineral possess a remarkable iridescent chatoyancy, or internal reflection of prismatic hues, especially bright blue and green, with more or less golden yellow, peach colour, and red. From its remarkable play of colour it has become a great favourite with many connoisseurs, and at one time was much used for cameos. The colours are best seen when the stone is polished flat, parallel to the reflecting surfaces.

In addition to the brilliant iridescence, many specimens of Labradorite exhibit a beautiful spangled appearance, like that of Avanturine. The iridescence is due to the presence of numberless thin plates, which give rise to what are called "interference phenomena," whereby a peculiar brilliancy is obtained, something like that on a peacock's feather. The spangled effect is attributable to very minute plates of oxide of iron distributed through the stone. It is not, however, every piece of Labradorite that exhibits these phenomena. The stones which have the most beautiful colours come from the coast of Labrador and St. Paul's Island, where they occur in masses, and from Norway, where they are found as loose blocks.

Great care has to be taken in the manipulation of this stone to preserve the play of colour; for if any facets are given to it, this generally disappears. The first block of Labrador was brought to Europe in 1775, and the rock was discovered in Russia in 1781. Still later, two blocks were found on the shores of the Paulovka, which exceeded all hitherto known specimens in size, one weighing 1,000 lbs.

LABRADORITE.

Composition:—Silicate of aluminium, calcium, and sodium.

Silica	52·9
Alumina	29·3
Lime	12·3
Soda, etc.	5·5
	100·0

Specific Gravity	2·7
Hardness	6
Crystalline System	Triclinic.
Form	Usually in cleavable masses.

CHAPTER XXI.

LAPIS-LAZULI.

THIS stone is remarkable for its beautiful blue colour, whence the Arabians call it *Azul*, meaning "blue." Theophrastus describes a blue stone "spotted with gold dust," while Pliny speaks of it as being "like to the serene blue heavens, fretted with golden fire." The "gold" mentioned by these and other ancient authors refers to the spangles of brass-like iron-pyrites which are commonly dispersed through the rich blue substance of the Lapis-Lazuli.

The colour of the stone varies from pale azure to deep blue, with a tint of green; but is seldom quite pure, being often mottled with white and yellow spots. Indeed, the Lapis-Lazuli is not a homogeneous substance, but consists of a definite blue mineral, which is probably referable to the species *Haüyne*, associated with a colourless substance, whence its mottled appearance. It is brittle, has but little lustre, and is translucent only at the corners of thin edges.

The precise origin of the beautiful blue colour of the Lapis-Lazuli is still a matter on which chemical opinion is divided. It is usually referred to the presence of a sulphide, probably of sodium and iron, but it appears likely that the sulphur is present in the form both of a sulphide

and of a sulphate. Lapis-Lazuli fuses with great difficulty, and expands before the blow-pipe, after which it becomes a porous, colourless glass; but if heated with saltpetre, it turns to a beautiful green.

In the Cordilleras, near the sources of the Cazadero and Vias—little tributaries of the Rio Grânde— not far from the high road leading to the Argentine Republic, and a short distance from the great watershed in the Chili dominions, the Lapis-Lazuli is found in a thick stratum of carbonate of lime, accompanied by small quantities of iron pyrites.

Lapis-Lazuli is also found in Siberia, on the shore of the Shudank, particularly on the lands near the Baikal Lake, into which that river empties itself. Marco Polo, in his travels to the princes of Tartary in 1271, found it in the upper district of the Oxus, mixed with iron ore, whence the Armenian merchants still bring it to the market of Orenburg, in Eastern Russia. In many provinces of China, and in Bucharia, it is found in granular limestone with iron pyrites, and, on the banks of the Indus, in a greyish limestone.

In Italy it is a favourite stone for ornamenting churches, and in the chapel of San Martini, at Naples, the Lapis-Lazuli is profusely employed not only for decorative work, but even as a structural material. In the Zarskoe Palace, near St. Petersburg, there is an apartment, called Catherine II.'s chamber, formed entirely of Lapis-Lazuli and Amber.

This stone was in early times much valued, because it was the only material from which the true ultra-marine of the artist, so celebrated for its effect and permanence, could be obtained. Artificial ultra-marine is now prepared

on a very large scale, at a cheap rate, and closely resembles the natural pigment, not only in its splendid colour, but even in its chemical composition.

LAPIS-LAZULI.

Composition:—

Silica	45·5
Alumina	31·8
Soda	9·1
Lime	3·5
Iron	0·8
Sulphuric acid	5·9
Sulphur	0·9
Chlorine	0·4
Water and loss	2·1
	100·0

Specific Gravity ... ... 2·3 to 2·5
Hardness ... ... 5·5
Crystalline System ... ... Isometric.
Form ... Dodecahedron, but very rare; generally massive.

CHAPTER XXII.

MALACHITE.

THERE can be little doubt that this stone was known to the Ancients, and it has been suggested that our Malachite was the *Smaragdus Medicus* of Pliny.

Malachite, a hydrated carbonate of copper, is found in almost every locality which yields copper-ores, occurring principally in the upper parts of the deposits where atmospheric influences have been at work. The finest specimens have been obtained from the mines of the Urals, and from the great deposits of copper-ore in South Australia.

Malachite is occasionally found in crystals, but perfect specimens are rare. It usually occurs in masses with rounded surfaces—mammillated, botryoidal and reniform—which have evidently been deposited from solution in water, much in the same way that deposits of stalagmitic marble have been formed. Its gradual deposition in successive layers is shewn by the concentric structure which specimens of Malachite so often display, and owing to this structure, a slab of polished Malachite usually exhibits a beautifully variegated pattern.

MALACHITE.

Chemical Composition—	Copper oxide ...	71.9
	Carbon dioxide ...	19·9
	Water	8·2
		100·0

Specific Gravity	3·7 to 4·0
Hardness	3·5 to 4·0
Crystalline System	Monoclinic.

Form ... Usually modified oblique rhombic prisms, but rare; usually botryoidal or stalagmitic.

CHAPTER XXIII.

MOONSTONE, SELENITE, AND SUNSTONE.

MINERALOGISTS of the present day apply the name *Selenite* to the finer varieties of Gypsum—a common mineral much too soft to be of any real service in jewellery, yet presenting in its fibrous forms so pleasing a lustre as to be occasionally cut and polished as an ornamental stone. This fibrous Gypsum or Selenite occurs in the New Red Marls of Derbyshire and Staffordshire, and especially in the neighbourhood of Newark, in Nottinghamshire, where it is worked to a limited extent into beads and other trivial objects. Selenite derives its name from its soft lustre, suggestive of moonshine; but though the word literally signifies "moonstone," no jeweller would think of designating it by such a term—the word "moonstone" being invarably applied to an entirely different stone.

"The Selenite," says Adreas Baccius, "is a kind of gem which doth contain in it the image of the moon, and it doth represent it increasing and decreasing according to the increase and decrease of the moon, in its monthly changes." The Greeks called it *Aphroselene*, which signifies the splendour of the moon, or a beam of the moon, whilst the Romans called it *Lunaris*. Dioscorides says "it is found in Arabia, and is endued with virtues, as of making trees fruitful, and of curing epilepsy;" he adds that "in the night it will illuminate the place that is next to it."

Whatever the Moonstone of the Ancients may have been, the Moonstone of the present day is an opalescent

variety of orthoclase-felspar termed *Adularia*—a name which it derives from Mount Adula, one of the highest peaks of St Gothard, where it occurs. The best specimens however, come from Ceylon. There can be little doubt that the Romans received consignments of it, with the other products of Taprobane (Ceylon). The pleasing lustre of this stone has led to its use by the jeweller, and a short time ago it had a great run, but at present is quite out of fashion.

While one member of the Felspar group is known as Moonstone, another is recognised as *Sunstone*. This is a reddish or golden coloured variety of *Oligoclase*, exhibiting internal prismatic reflections and minute spangles due to the presence of included crystals of oxide of iron or of mica. It is found to a limited extent in Norway, and is but rarely employed in jewellery.

The *Chemical Composition* of the two Felspars may be taken as follows:—

Moonstone (Orthoclase).

Silica	64·7
Alumina ...	18·4
Potash... ...	16·9
	100·0

Crystalline System—Monoclinic.
Specific Gravity—2·5 to 2·6
Hardness 6

Sunstone (Oligoclase).

Silica	61·9
Alumina ...	24·1
Lime	5·2
Soda	8·8
	100·0

Crystalline System—Triclinic.
Specific Gravity... 2·5 to 2·7
Hardness 6

CHAPTER XXIV.

MOROXITE.

A DARK bluish-green variety of Apatite, or calcium phosphate, found originally at Arendal in Norway, and at Pargas in Finland, has been termed by mineralogists *Moroxite.* The name is fancifully derived from a certain Greek word applied to a stone used by the Ancients in bleaching linen. Clear crystals of Moroxite have occasionally been cut and polished, but their softness renders them ill-suited for jewellery. It appears that some of the material occasionally sold as Moroxite is nothing but paste.

MOROXITE.

Chemical Composition :—

Phosphoric Anhydride	41
Lime	55
Iron Oxide, Chlorine, &c. ...	4
	100

Specific Gravity	3·2
Hardness	5
Crystalline System	Hexagonal
Form ...	Six-sided prisms, variously modified.

CHAPTER XXV.

OBSIDIAN.

GEOLOGISTS apply this name to a volcanic glass or fused lava, and at first sight it may seem strange that such a substance should find a description in a work on Precious Stones. Obsidian was, however, used by the Ancients as an ornamental stone, and it is still occasionally cut and polished. It is generally of bottle-green colour, and when cut looks somewhat like a Peridot or a green Tourmaline. The great objection to the stone is its softness, which is rather less than that of Felspar. A brown streaked American variety is cut and polished under the name of *Mahogany Obsidian.* A Siberian variety, with a pleasing silvery sheen, is occasionally used in the manufacture of snuff-boxes and other ornamental articles. Curious globular masses of Obsidian, known from a Siberian locality as *Marekanite,* sometimes explode, when struck, like Ruperts' drops. "Obsidian bombs" are occasionally found in Western Australia, and elsewhere.

OBSIDIAN.

Chemical Composition :—

Silicate of alumina potash, iron and lime.

Specific Gravity	2·6
Hardness	6·5
Form	Amorphous.

CHAPTER XXVI.

ORIENTAL ONYX.

ONYX is a celebrated variety of tinted Agate, having its colours arranged in parallel strata. The Oriental Onyx is obtained from India, Egypt, Arabia, and Armenia. The inferior variety mostly comes from Uruguay, Bavaria and Bohemia.

About 50 years ago this Oriental Onyx was greatly valued in this country as an ornamental stone, and I remember £1000 being paid for a very fine row of beads of this Onyx, which was got together with much difficulty; but at the present time the stone has but little value.

Some stone, called by translators *Onyx*, ranked among the highest class of gems in the ante-Christian world. Pliny likens it in colour to the human finger-nail; and it is upon this similarity that its Greek name Onyx is based. The Greeks attached the following mythological origin to this stone; "Cupid, with the sharp point of his arrow, cut the nails of the sleeping Venus, which fell into the Indus; but as they were of heavenly origin they sank, and became metamorphosed into Onyx."

The Onyx has been chiefly used for necklaces, cameos, and costly vessels. In making the cameo, the figure is carved out of the light colour, and stands in relief on the dark ground.

Amongst the most celebrated of these cameos is the "Schaffhausen Onyx" — one of the most cherished, treasures of the Canton of Schaffhausen. The figure engraved on it is a female wearing a crown of honour, holding in one hand a horn of plenty, in the other a Mercury's staff. The figure Dr. Oeri identifies as "Pax," and the Cameo was cut between A.D. 68 and 82. It is of great historical interest, and is supposed to have been brought from Constantinople by Ortleib von Frohberg, who was a trusted friend of Konrad III. and Friedrich I, and took part in the Second Crusade.

One of the most famous of the Antique Cameos is the Mantuan Vase; the base is brown, and on it, in relief, are groups of white and yellow figures, representing Ceres and Triptolemus in search of Proserpine. The Vase is formed from a single stone, and is seven inches high and two-and-a-half broad. In the Museo Nazionale, at Naples, there are many Cameos in Onyx; one (eleven inches by nine) representing the apotheosis of Augustus; and another with the head of Medusa carved on one side, and the apotheosis of Ptolemy on the other.

Onyx has been found in such large masses that small pillars have been made of it: there are six such in the Basilica of St. Peter, at Rome. At Cologne, in the Temple of the Three Magi, there is one broader than the palm of the hand. Appianas says that Mithridates, King of Pontus, had 2,000 cups of this gem; it is scarcely possible, however, to believe that they could have been of true Onyx; probably they were simply Onyx-marble.

By modern mineralogists the term Onyx is restricted to an Agate-like substance, formed of alternating white and brown or black layers of Chalcedony. When the

white zone is so thin that the deeper dark-coloured layer shines through with a bluish tint, the stone is called a *Nicolo*, an Italian corruption of "Onicolo" or "Little Onyx." If the strata be alternately white and red, or reddish-brown the resulting mixture is known as *Sardonyx.*

The finest specimens of Onyx are often termed Oriental," whatever their original locality may have been.

ORIENTAL ONYX.

Composition—Silica, with traces of colouring matter

Specific Gravity	2·6
Hardness	7
Form	Amorphous.

CHAPTER XXVII.

PERIDOT OR CHRYSOLITE.

THIS is a very ancient stone, and is said to have been, at one time, considered of more value than the Diamond, but the author cannot believe this statement.

In the Wardrobe Book of Edward I., the Peridot is mentioned among the jewels of the deceased Bishop of Bath and Wells, which were escheated to the Crown.

The Peridot has a very pleasing yellowish-green colour, and is susceptible of a fine polish, but it is so soft as to be easily scratched. It is a stone that requires considerable skill and care in polishing, the final lustre being imparted to it by means of sulphuric acid. It usually occurs in fragments much worn by the action of water, but well-defined crystals have been found, which prove that its native form is that of the rhombic prism.

Although the Peridot has not retained its pristine repute, it is still in demand. The gem looks well if judiciously set in gold, and the deeper the green the more valuable the stone, but it requires Diamonds to set off its beauty.

It has been pointed out in treating of Chrysoberyl, that, owing to lapidaries calling that stone the "Oriental Chrysolite," considerable confusion has arisen between the two gems. A comparison of their chemical composition

is, however, sufficient to shew that scarcely any two minerals differ more widely in their constitution—the one being an aluminate of glucina, the other a silicate of magnesia. The Chrysolite of mineralogy is in fact, practically the same stone as the Peridot.

Mineralogists include the Chrysolite and the Peridot under the one species *Olivine.* The colors of Olivine vary from light straw yellow to yellowish green, when the stone receives the name of Chrysolite; and thence to a peculiar soft hue, of a delicate deep yellowish green, when it is called Peridot. It is found in Egypt, Brazil, Mexico, Arizona, South Africa, and other countries, generally as small pebbles, and it occurs in fragments in most of the gold drifts of New South Wales. Of late a large quantity of rough Peridot has come into the market from two new mines.

PERIDOT OR CHRYSOLITE.

Chemical Composition: —

Silica	39·73
Magnesia	50·13
Ferrous oxide	9·19
Nickel oxide, &c.	·95
	100·00

Specific Gravity ... ... 3·35

Hardness ... ... 6·5

Crystalline System ... ... Trimetric.

Form ... Generally in water-worn pebbles.

CHAPTER XXVIII.

PHENAKITE.

OF late years this rare mineral has occasionally been used in Russia as a gem-stone. The kind employed for this purpose is perfectly transparent and colourless, exhibiting when skilfully cut great brilliancy, and bearing much superficial resemblance to Diamond.

Phenakite—like the Emerald, the Chrysoberyl, and Euclase—contains the rare metal glucinum or beryllium. The finest Phenakite occurs in mica-schist at Stretnisk, on the River Takowia, not far from Ekaterinburg, in the Urals. It is also found in Norway, and at Pike's Peak, in Colorado, but is, in all localities, a rather scarce mineral.

PHENAKITE.

Chemical Composition :—

Silica	54·2
Glucina	45·8
	100·0

Crystalline System	Rhombohedral.
Specific Gravity	3
Hardness	7·5 to 8
Form	Prismatic crystals.

CHAPTER XXIX.

QUARTZ CAT'S EYE.

FOR a description of Quartz Cat's Eye, and the True Cat's Eye, see pp. 211 to 213. Thin fibres of asbestos interspersed with regularity in the quartz give rise to the characteristic appearance of this stone. It is brought chiefly from Ceylon, and from Hof in Bavaria.

The Crocidolite, or "Wood Cat's Eye," of South Africa, known also as "Tiger's Eye" and "Hawk's Eye," has been described at pp. 257, 258.

Neither the quartz Cat's Eye, nor the South African Crocidolite is of more than trivial value.

CHAPTER XXX.

RHODONITE.

It is the rose-red colour of this mineral which has gained for it the name of Rhodonite (from the Greek *rhodon*, a rose); and it is this colour also which gives it a place among ornamental stones. Rhodonite is an opaque silicate of manganese' found in masses, sometimes of considerable size, especially near Ekaterinburg, in the Urals. By the Russian lapidaries it is occasionally worked into vases and other ornamental objects. It also occurs at Kapink, in Hungary, where it is associated with black oxide of manganese, which gives a variegated colour to the stone. It is only certain varieties of Rhodonite which can be advantageously used by the lapidary.

RHODONITE.

Chemical Composition :

Manganese oxide	54·2
Silica	45·8
	100·0

Crystalline System	Triclinic
Specific Gravity	3·6
Hardness	5·5
Form ...	Rarely crystallized ; usually massive.

CHAPTER XXXI.

ROCK CRYSTAL.

"WHEREOF the common opinion hath been, and still remaineth among us," said the learned Sir Thomas Browne, in his famous work on *Vulgar Errors*, in 1646, "that Crystal is nothing else but ice or snow concreted, and by duration of time congealed beyond liquation. Of which assertion, if prescription of time and numerosity of assertors were a sufficient demonstration, we might set down herein as an unquestionable truth; nor should there need ulterior disquisition. For few opinions there are which have found so many friends, or been so popularly received through all Professions and Ages." The word *crystal* is, in fact, a standing testimony to this strange belief, since it owes its origin to the Greek word *krustallos*, which means "ice." Pliny, Seneca, and other ancient writers—not to mention Austin, Gregory, Jerome, and several early fathers of the Church—have given their adhesion to the opinion that Rock Crystal is nothing but water congealed by a cold so intense that ordinary methods fail to melt it.

Modern science, however, dispelling such illusions, has proved that Rock Crystal is a pure and limpid form of Quartz—a natural variety of silica.

Rock Crystal is found in a variety of forms, sometimes of extraordinary size and beauty. Its colour varies from pure white to greyish-white, yellow-white, yellowish-brown, clove-brown, and black. According to its colour it receives a variety of names: thus the yellow is known as *Citrine* and *False-Topaz*, the brown as *Cairngorm* and

Smoky-Quartz, and the black as *Morion.* The clear varieties are transparent, and possess double refraction.

The frequent admixture of chlorite, asbestos, rutile, iron pyrites, and actinolite in the crystals is very remarkable. In some specimens there are cavities with liquid enclosures, which move as the crystal is turned. The brilliant hair-brown needles of Rutile, penetrating the crystal in all directions, impart a curious appearance to the stone, and such specimens are often cut for brooches, under the name of *Flèches d'Amour*, or "Cupid's arrows," or "Venus's Hair-Stone." It is also known as *Sagenite*, or *Sagenitic quartz.*

Among European localities for Rock Crystal, the most remarkable are those in Switzerland. A little distance from the Grimsel, it is found in the mines of Jochle Berg and Zinkenstock. In 1735 the yield from the cave of Zinkenstock alone was valued at £2,250. The most famous mine, perhaps, is that of Fischbach, in the Visperthal, which supplied the crystal for the great Pyramid of Marsfield, 1797. This block measured three feet in diameter, and weighed over 800 lbs. It is now in the Natural History Museum at Paris.

The most remarkable discovery of Rock Crystal on record is that which was made in 1867 at the Galenstock, above the Tiefen Glacier, by a party of tourists under the guide Peter Sulzer, of Guttannen. A cave in the granite yielded more than a thousand crystals, all of large size, and weighing from 50 lbs. each to upwards of 3 cwt. They were, however, of dark colour. In the Museum at Berne there are some magnificent crystals from this lucky discovery. One gigantic crystal, known as the "Grandfather," weighs as much as 276 lbs.; while another, christened "The King," weighs 255 lbs.

In the clear cavities of the snow-white marble of Carrara, in Tuscany, Rock Crystal is found in great purity. Ceylon affords it abundantly; and Madagascar supplies large blocks; but it is from Brazil that our chief commercial supply is obtained, much of it being imported for the use of the optician, who cuts and polishes it in the form of spectacle lenses, which are known as "pebbles."

In this country Rock Crystal of small size is not uncommon, and has been occasionally used as an ornamental stone, under the local name of "Diamond," such as "Bristol Diamonds," "Irish Diamonds," and "Isle of Wight Diamonds." These are of no value whatever.

The Greeks valued Rock Crystal for its purity and regular form. Pliny mentions several times in his Natural History, that the Romans were well acquainted with its habitat in the Alps, and that they employed it largely for household luxury and adornment. Nero possessed two very beautiful drinking cups, one of which cost him a sum equal to £600. When he heard of the loss of his kingdom, he is said to have broken them in anger. The Roman physicians used Crystal balls as lenses, in order to burn out sores; and spheres of Rock Crystal have been used, even in modern times, for divination.

ROCK CRYSTAL.

Composition—Oxygen	... ...	53·3
Silicon	... ...	46·7
		100·0
Specific Gravity	... ...	2·65
Hardness	... ...	7
Crystalline System	.. ...	Rhombohedral.

Forms ... Various six-sided prisms, terminating in pyramids.

CHAPTER XXXII.

SPHENE.

SPHENE is a mineral which has occasionally been cut as an ornamental stone. Its appearance is somewhat between that of Opal and Chrysolite. In colour it varies from pale yellow to green; and it exhibits all degrees of transparency, some varieties being, however, opaque. Only the most transparent and clear specimens have the claim to be classed as gem-stones; and although the mineral has a remarkably brilliant dispersive power, its softness is against its ever being extensively used. Among its many localities mention may be made of Arendal, in Norway, of St. Gothard and Mont Blanc, and many parts of North America.

SPHENE.

Composition:—	Titanic Oxide ...	41
	Silica	31
	Lime	27
	Iron Oxide	1
		100

Specific Gravity	3·5
Hardness	5 to 5·5
Crystalline System	Monoclinic.
Form	Wedge-shaped crystals

CHAPTER XXXIII.

SPODUMENE.

OF late certain varieties of this mineral have been cut as gem-stones. Its colours vary from greyish to greenish yellow; some varieties are opaque and others transparent. Although susceptible of high polish, it is a very difficult material to work, partly because it is much harder in one direction than another, and partly on account of its remarkably easy cleavage, which renders it liable to split.

Spodumene is found in a large number of localities, but the transparent variety, which alone has been cut as an ornamental stone, is confined to Brazil.

The mineral previously described as *Hiddenite*, or "Lithia Emerald," is only a variety of Spodumene.

SPODUMENE.

Composition:—	Silica	64.5
	Alumina	29·0
	Lithia	5·5
	Iron oxide and soda	1·0
		100·0

Specific Gravity 3

Hardness 7

Crystalline System ... ... Monoclinic.

Form ... Usually in fragments, exhibiting two parallel cleavage planes.

CHAPTER XXXIV.

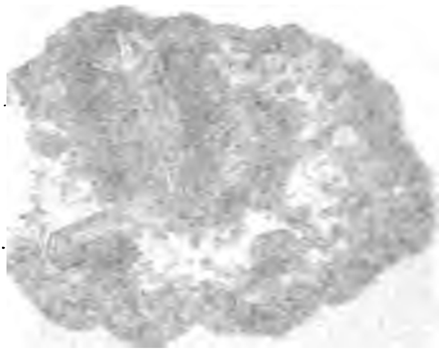
TOPAZ.

THE name of this stone is derived from the Greek *Topazios*—a word which appears to have been sometimes wrongly applied to the Chrysolite or Peridot. This was probably the ancient classic gem, called in Hebrew *Pittdoh* by Professor Aaron Pick, and *Pitdah* by Genesius (according to the Massoreth), the latter of whom imagines that it is derived from the Sanscrit *pita* (pale), and that the Greek *Topazios* s a transposition from *Pitdoh* to *Tipdoh*. The ancient mineralogists described this as a pale yellowish or greenish gem found in an island of the Red Sea. Boetius says it is of a "diluted green colour with yellowness added to it." Among the virtues then attributed to it we read that "the Topaz calms anacreontic temperaments."

Under the general name of *Topaz* modern mineralogists include three distinct stones—(1) the *true* Topaz; (2) the Yellow Sapphire, or the *Oriental Topaz*; and (3) the *Occidental* or *False Topaz*. The second is a yellow Corundum, and the third is only a variety of Scotch Quartz.

The true Topaz presents a variety of colours, from clear white, when it has been occasionally palmed off as a Diamond, ranging through all shades of light blue and light green to rose pink, orange, and straw yellow. A pink colour is frequently obtained by subjecting the sherry-coloured Topazes to a moderate temperature. The instability of colour in certain Topazes is attested by the bleaching which they suffer on exposure to sunlight.

Crystals of Topaz are remarkable for their *pyro-electricity* — in other words they become electric on exposure to heat.



CRYSTALS OF BRAZILIAN

CHAPTER XXXIV.

TOPAZ.

THE name of this stone is derived from the Greek *Topazios*—a word which appears to have been sometimes wrongly applied to Chrysolite or Peridot. This was probably the ancient classic gem called in Hebrew *Pitdah* by Prof. Aaron Pick, and *Pitdah* by Genesius (according to the Masoretic), the latter of whom imagines that it is derived from the Sanskrit *pita* (pale), and that the Greek *Topazos* is a transposition from *Pitdah* to *Tipdah*. The ancient mineralogists described this as a pale yellowish or green [illegible] found on an island in the Red Sea. Boetius [illegible] tinted green colour with yellowness added [illegible] the virtues then attributed to it were [illegible] that the Topaz calms anacreontic temperaments."

[illegible] The general name of *Topaz* [illegible] applied to three distinct stones—(1) the *true* Topaz, (2) the Yellow Sapphire, or the *Oriental Topaz*, and (3) the [illegible] or *False Topaz*. The second is a yellow corundum, and the third is only a variety of Scotch Quartz.

The true Topaz presents a variety of colours from clear white, when it has been occasionally palmed off as a Diamond, ranging through all shades of light blue, light green to rose pink, orange, and straw yellow. Pink colour is frequently obtained by subjecting the [illegible] coloured Topazes to a moderate temperature. The instability of colour in certain Topazes is attested by the bleaching which they suffer on exposure to sunlight.

Crystals of Topaz are remarkable for their [illegible] *electricity*—in other words they become electric on exposure to heat.

CRYSTALS OF BRAZILIAN TOPAZ.

Tavernier, in 1665, saw a Topaz weighing 157 carats in the treasury of Aurungzeb, which that monarch had purchased for a sum corresponding to £18,000 of our money: to-day it would be dear at £180.

The Topaz mines of Brazil are near Ouro Preto, formerly known as Villa Rica. In the Urals, north of Ekaterinburg, Topaz is found in granite. In St. Petersburg there is exhibited a fine crystal, 4¾ inches long and 4½ wide. In the east of Siberia it is found in blue crystals, in company with Beryl, Rock Crystal, and Felspar. A remarkably fine collection of Siberian Topazes, made by Prof. Kokscharow, of St. Petersburg, may be seen in the Mineralogical Gallery of the British Museum (South Kensington), where the finest crystals are carefully protected by opaque caps to shield them from sunlight, by which they might suffer loss of colour.

Topaz is found in Egypt, near the ancient Emerald Mines of Jebel Zabbara. The mineral is still worked at Risk Allah.

In Saxony the white, yellow, and the pale violet crystals are found, and in Bohemia the sea-green variety. The Saxon Topazes are obtained chiefly from the well-known Topaz-rock of the Schneckenstein. In Brazil, red specimens graduating from a pale to a deep carmine tint, have been discovered; but most of the Brazilian Topazes are of a rich wine-yellow colour. The white Topazes of Brazil are frequently known as *Novas Minas*. The blue Topaz from Brazil somewhat resembles Aquamarine, but is distinguished by its greater hardness and higher specific gravity.

White Topaz is found in Flinders's Island, in Bass's Straits; in the New England district, New South Wales; and in various parts of the United States. Fine blue crystals have been discovered at the famous mineral locality of Pike's Peak, Colorado, and the species has also

been found at Stoneham, in Maine. It is notable that Topaz is not uncommonly found in connection with ores of tin in all parts of the world.

The Topaz is one of the few Semi-Precious Stones found in the British Isles. It occurs at St. Michael's Mount, Cornwall; in the Mourne Mountains, Co. Down; and in several Scotch districts.

Several engraved Topazes are known; that in the Bibliothèque Royale, in Paris, is set as a signet ring, having the portraits of Philip II. and Don Carlos deeply cut in it. There is also a citron-yellow Topaz, representing an Indian Bacchus. The antique Topaz in St. Petersburg, engraved with the representation of Sirius, is of excellent workmanship.

The *Goutte d'Eau*, which is capable of exquisite polish, is a colourless Topaz. If cut as a Brilliant, with a small table, the pure gem forms a beautiful ornament; and some specimens found in New South Wales and in Brazil, are worthy of careful cutting, polishing, and setting.

The chemical composition of the Topaz, in addition to its obvious characteristics, confirms its title to a high rank among ornamental minerals.

TOPAZ.

Chemical Composition:—

Aluminium	30·2
Silicon	15·5
Oxygen	36·8
Fluorine	17·5
	100·0

Specific Gravity ... ... 3·5

Hardness 8

Crystalline System ... ... Rhombic.

Form ... Prisms, terminating with pyramids; the two ends usually dissimilar; with strongly-marked basal cleavage.

CHAPTER XXXV.

TOURMALINE.

THE Dutch are said to have introduced Tourmaline into Europe, from Ceylon. The first written history of the stone is found in a book published at Leipzig, in 1707, called "*Curious Speculations of Sleepless Nights.*" It is mentioned also in the catalogue of a collection of stones sent over from Ceylon to Leyden in 1711. For many years small quantities only of this stone were sent to Europe, and the German Jews were almost its only purchasers.

Few minerals present greater complexity of chemical constitution than the Tourmaline. Its composition has been said to resemble the prescription of a mediæval doctor, in which a little of everything was thrown in; and a reference to the analysis appended to this chapter will illustrate this intricacy of constitution. To the student of physics, the Tourmaline is a stone of singular interest, from the curious optical and electrical characters which it exhibits. It enjoys, in its different varieties, a very wide range of colour, though it rarely displays any vivid or brilliant hue; hence it has become a great favourite with connoisseurs, who can appreciate its soft and sombre tones, but has not acquired general popularity. Its colours consist of various shades of grey, yellow, blue, pink, and brown; all having a tendency towards the darker hues, even to black.

The Tourmaline passes under a variety of mineralogical names, according to the colour which it presents. The red varieties are known as *Rubellite*, the blue as *Indicolite*, and the clear and colourless crystals as *Achroite*; while the common black Tourmaline is still distinguished by the old German name of *Schorl.*

It often happens that the colour is not constant throughout the stone, so that one part may be green, while another portion of the same crystal may be decidedly pink. An American variety is notable for presenting a central kernel of red colour, surrounded by a zone of lively green, and as such crystals are usually three-sided prisms, they offer, when cut across, a triangular or heart-shaped section, with the pleasing effect of a red centre fringed by a green border.

Tourmaline possesses double refraction, and polarizes light perfectly: hence it is used by opticians in the construction of polariscopes. Its dichroism is very pronounced, and may be often recognised without the aid of an instrument.

Tourmaline, in common with many other Precious Stones, develops electricity under friction. Many Tourmalines also acquire electric properties when heated—one end of the crystal becoming positive and the other negative. This phenomenon is known as *Pyro-electricity*. It is connected with the curious form of most of the crystals, their two extremities exhibiting different faces. This peculiarity of shape is termed *hemimorphism*, since half of the crystal presents one form, and half another. When the temperature of a hemimorphic crystal is either raised or lowered, its electric equilibrium is disturbed, and polarity developed; so that the condition of the crystal may then be compared with that of a magnet.

Prof. Miers has shewn that when a mixture of red-lead and flowers of sulphur is sprinkled, through a muslin sieve, on to a Tourmaline which having been warmed is slowly cooling, the orange powder is at once separated into its components; the red-lead, becoming positively electrified by friction through the sieve, flies to the negative end of the Tourmaline, whilst the sulphur being negatively electrified, attaches itself to the positive end.

Tourmaline is found in Siberia, Ceylon, the Urals, Burma, Saxony, and the Isle of Elba. In the United States, it has been discovered in great perfection and abundance, especially at Mount Mica, Paris, Maine.

The Siberian Tourmaline is of carmine, hyacinth, purple, or rose-red, running into violet-blue. When polished its lustre somewhat resembles that of the Ruby, and the mineral is sometimes known as "Siberian Ruby."

The Green Tourmaline generally occurs of an olive or dark green colour, and takes a perfect polish. Crystals of great beauty are found in Minas-Geraes. The Yellowish-Green Tourmaline, "Ceylon Chrysolite," is very like an Aquamarine, and is found in the river beds of Ceylon and Brazil. Colourless Tourmaline occurs very seldom in pieces worth the cost of cutting and polishing. Brown and Black Tourmaline are varieties not used for purposes of ornament. Black Tourmaline or Schorl is by no means uncommon in this country, especially in the tin-bearing districts of Cornwall.

The value of Tourmaline depends upon the colour, quality, and size of the specimens; one of exceptional colour and purity, of five carats weight, might be worth about £20, but others only a few shillings.

A very large specimen of Rubellite, or Red Tourmaline, from Burma, is exhibited in the Mineralogical Gallery of the British Museum (South Kensington). This unique group of crystals was presented by the King of Ava to Colonel Symes when on an embassy to that country, and has been valued at £1000. It has probably lost much of its original colour and value.

The author has received a very fine piece of reddish Tourmaline from the Cashmere Sapphire Mines and several pieces from the Burma Ruby Mines.

TOURMALINE.

Composition—Very complicated and varied. According to Rammelsberg, a green Brazilian stone gave—

Silica	38·55
Alumina	38·40
Boron trioxide	7·21
Ferric oxide	5·13
Ferrous oxide	2·00
Soda	2·37
Fluorine	2·09
Lithia	1·20
Lime	1·14
Manganic oxide	0.81
Magnesia	0.73
Potash	0·37
	100·0

Specific Gravity ... ... 3.0 to 3·15
Hardness ... ... 7·5
Crystalline System ... ... Rhombohedral.
Form ... ... Usually in prisms striated vertically, and differently terminated at opposite ends.

CHAPTER XXXVI.

ZIRCON OR JARGOON.

THE Zircon is a lovely stone, the red and brown varieties being especially noteworthy. Some of the finest Jargoons present yellow, green, and blue tints, not unlike those of the Tourmaline, but with much more fire and lustre. Some specimens when submitted to great heat, increase in lustre, but at same time lose colour.

The Zircon is distinguished when in its natural form, by its quadrilateral crystals, terminating at both ends in a pyramid. It is of adamantine lustre, transparent to sub-translucent. In former times this gem was more highly valued than at present.

Although the localities which yield Zircons fit for working into ornamental stones are but few, it should be borne in mind that the coarser forms of Zircon are present in a great variety of rocks, such as the Zircon-syenite of Norway and Siberia.

Nicols writing of Zircons 230 years ago, says—"They are found in Ethiopia, India, and Arabia. The Arabs distinguish three kinds—1, Rubri Coloris: 2, Citrini Coloris: 3, Antimonii Coloris. Of these the worst is found in the river Iser, which is upon the confines of Silesia and Bohemia."

Klaproth in 1789 discovered in the Zircon an earthy basis, to which he gave the name of Zirconia. It is the

oxide of a peculiar metal called *Zirconium*, of which the gem itself is a silicate. The word *Zircon* is of Arabic origin.

There is a splendid specimen of a very ancient engraving on a Zircon in the Paris Museum, the workmanship of which is exquisite; it is about 2 inches in length, and 1¼ in width, and represents Moses with the two tables of the law. Lord Duncannon had in his collection a Zircon with an engraving on it representing an athlete.

According to mineralogists, the red and brown varieties of Zircon form the true *hyacinth* and *jacinth*; though the stones so called, commercially, are often Essonite, which is a stone belonging to the Garnet family. The hyacinthine Zircon occurs in the gem-drifts of Australia.

ZIRCON OR JARGOON.

Chemical Composition:—	Silica ...	34
	Zirconia ...	66
		100

Specific Gravity ... ... 4 to 4.86
Hardness ... ... 7·5
Crystalline System ... ... Tetragonal.
Form ... Tetragonal prism with pyramidal termination: often as rolled pebbles.

A CLASSIFICATION OF
PRECIOUS AND SEMI-PRECIOUS STONES,
under seven separate heads,
according to their
CHEMICAL COMPOSITION.

---

1. ELEMENTS:

    DIAMOND (*Carbon*).
        Bort.
        Carbonado.

2. OXIDES:

    CORUNDUM (*Alumina*)
        Ruby.
        Sapphire.

    HÆMATITE (*Ferric Oxide*).

    QUARTZ (*Silica, Crystallized*).
        Rock Crystal.
        Amethyst.
        Cairngorm or Scotch Topaz.
        Avanturine.
        Quartz Cat's-eye.

    CHALCEDONY (*Silica, Crystalline*)
        Carnelian.
        Chrysoprase.
        Onyx.
        Agate.
        Heliotrope or Bloodstone.

OXIDES—(*continued*)

JASPER (*Silica, compact*).

OPAL (*Silica, hydrated*).

3. <u>ALUMINATES</u>:

SPINEL.
Balas Ruby.

CHRYSOBERYL.
Oriental Cat's-eye.
Alexandrite.

4. <u>SILICATES</u>:

BERYL.
Emerald.
Aquamarine.

EUCLASE.

PHENAKITE.

ZIRCON.
Jargoon.
Hyacinth or Jacinth.

TOPAZ.

OLIVINE.
Chrysolite or Peridot.

DICHROITE or IOLITE.

GARNET.
Essonite.
Almandine.

SILICATES—(*continued*).

Carbuncle.
Pyrope.
Grossularia.
Demantoid.

TOURMALINE.

SPODUMENE.
Hiddenite.

ANDALUSITE.

SPHENE.

FELSPAR.
Moonstone.
Sunstone.
Labradorite.
Amazonite.

OBSIDIAN.

RHODONITE.

JADE.
Nephrite.
Jadeite.

LAPIS-LAZULI.

5. PHOSPHATES:

TURQUOISE.
Odontolite.

MOROXITE.

6. CARBONATES:

MALACHITE.

7. ORGANIC:

AMBER.

JET.

PEARLS consist essentially of Carbonate of Lime, and would therefore come under the class of "Carbonates," numbered 6 in the above scheme of Classification. But as Pearls are formed by certain Mollusca, they must be regarded as *organic* products, and should consequently be placed in class 7. It is, however, not correct to include them in any scheme for the Classification of Mineral substances.

Composition:—(From the Pearl found in Australia and Ceylonese fisheries). Identical in a sample from each fishery.

Carbonate of Lime	91·72	per cent.
Organic matter	5·94	"
Water	2·34	"
	100·00	

APPENDIX A.

On the Discrimination of Precious Stones,

Enabling anyone to test the nature of Different Gems.

THIS Appendix has been prepared with the view of aiding those readers who may wish to become acquainted with some of the scientific means employed in the critical examination of Precious Stones. As information of this kind is necessarily somewhat technical, and must be conveyed in scientific language, it has been considered desirable to add it in the shape of an Appendix rather than to incorporate it in the body of the work.

The Hardness of Gems.

The hardness of a mineral is a physical characteristic of considerable importance as a test, inasmuch as it is found to be fairly constant in each species. In order to give something like quantitative precision to this test, a German mineralogist named Mohs, long ago suggested a standard scale of comparative hardness, which is generally used at the present day by mineralogists. At the head of this scale stands the Diamond, the supreme hardness of which is a character defying imitation. The various degrees of the scale are numerically ranged as follows, the hardest being placed at the top of the list, with

the highest number, and the softest at the bottom of the scale:—

10. Diamond.	5. Apatite.
9. Sapphire.	4. Fluorspar.
8. Topaz.	3. Calcite.
7. Quartz.	2. Gypsum.
6. Felspar.	1. Talc.

To ascertain the hardness of a stone, rub it over the edge of another stone of known hardness. If it neither scratches nor is scratched by it the two are identical in degree of hardness. If it scratches, say, No. 7, but is scratched by No. 8, its hardness will lie between the two numbers. Simple as the test seems to be, it requires considerable skill in some cases to obtain satisfactory results.

To the student of Precious Stones it is only the first four degrees of hardness that are of interest. It is convenient to have representatives of these mounted in tubes, or handles, for ready use. A small case containing these stones, conveniently mounted, may be purchased for a guinea, and will enable any ordinary judge to test a doubtful stone.

The Diamond (No. 10) scratches every other stone. The Sapphire (No. 9) stands next in hardness to the Diamond, and scratches all inferior stones. The Topaz (No. 8) and the Rock Crystal (No. 7) are the only other minerals likely to be of service

The Opal, Turquoise, Moonstone and Sphene are all inferior to Quartz in hardness; or, in other words, fall below No. 7 in the standard scale.

SPECIFIC GRAVITY.

As specific gravity is a readily applicable, yet invaluable, aid in the discrimination of Precious Stones, a description of the usual modes of taking the specific gravity of a mineral may be useful. By specific gravity is meant the relative weights of equal bulks of different kinds of of matter. Distilled water at 60 degs. F. is usually taken as the unit of comparison, so that if a gem weigh 3½ times as much as an equal bulk of water, under the above conditions, it is said to have a specific gravity of 3·5.

One method, now much used, consists in placing the gem in a liquid of known specific gravity, and observing whether it sinks or floats. The liquid must necessarily be of very high specific gravity if it is to be of any use in dealing with gems. Such a liquid as that discovered by Mr. Sonstadt, and called after him "Sonstadt's Solution," has been used. This is a solution of mercuric iodide in
...m iodide, and can be prepared of any specific
...o about 3. *It is, however, very poisonous, and*
... *with the greatest caution.* It is often known
...nent as Thoulet's solution.
...solution, any stone in the following list would
...rmaline, Turquoise, Emerald, Beryl, all the

varieties of Quartz, and Moonstone. On the other hand Garnet, Sapphire, Ruby, Chrysoberyl, Spinel, Topaz, Diamond, and Chrysolite, from their greater specific gravity, would *sink*.

Of late years Sonstadt's solution has been replaced by other liquids of even higher density. Thus, the boro-tungstate of cadmium is a salt which gives a pale-yellow solution of the density of 3·28. This is known, from its discoverer, as Klein's solution. Methylene iodide, again, is a very convenient liquid, its specific gravity being about 3·3, or slightly higher. It is a yellow liquid, readily miscible with benzene; and its use was suggested by Dr. Brauns.

But the densest of all liquids, as discovered by Dr. Retgers, is the fused nitrate of thallium and silver, which has a specific gravity of about 5, and fuses at as low a temperature as 75° C., or 167° Fah. Thus, at a temperature considerably less than that of boiling water, the salt forms a liquid, which is clear and colourless, and may be mixed in any proportion with water, whereby its density can be reduced at will.

Another method of taking specific gravities is by weighing the stone first in air and then in water, and dividing the former weight by the difference between the two weighings. A simple method, and one generally of sufficient accuracy, is to employ a first-class pair of Diamond scales, as follows: Drill a small hole in the bottom of one of the scale pans, through which pass a double fibre of silk, so as to hang say 4 inches below the pan; tie a knot to prevent its slipping through; suspend the stone in the silk by bending back the silk upon itself, so as to form a double slip noose; and weigh the stone very carefully while hanging suspended in this position. Then immerse the stone, as it hangs, in distilled water. It will appear to

have lost weight, being, in fact, buoyed up by the water; now add carefully more weights, till an equipoise is effected; note the weight by which this is obtained, and divide the original weight of the stone by it, and the quotient will give the specific gravity required.

Example: In weighing a white stone whose specific gravity we required, we found the weight of the stone to be 4, $\frac{1}{2}$, $\frac{1}{16}$, $\frac{1}{64}$ carats. The weights effecting the equipoise, 1, $\frac{1}{4}$, $\frac{1}{32}$, $\frac{1}{64}$ carats. We have, therefore, $\frac{293}{64} \div \frac{83}{64}$, or $\frac{293}{83} = 3{\cdot}53$, which is the specific gravity required. This would indicate the specific gravity of a Diamond.

Jolly's spring-balance, an instrument made in Munich, is often now used by mineralogists on the Continent, and enables the specific gravity of small specimens to be determined with great rapidity. Another instrument much used is the Westphal balance, named from its inventor, and constructed on the principle of the familiar steel-yard.

There are various other methods for determining this physical constant, but the above will suffice for ordinary purposes. Care should always be taken to have the stone perfectly clean, and damped before operation, whilst all adherent air-bubbles must be most carefully removed. In the preceding pages the specific gravity of each stone has been given at the end of its chapter.

The Optical Properties of Gems.

The optical properties of Gems are of paramount importance. It is to these properties that the Diamond owes its superlative brilliancy and its flashing forth of "living fire;" to these properties, too, the Ruby, owes its

intensity and delicacy of hue and beauty; in a word, the optical characters constitute a great gulf that divides the real stone from the imitation.

Reflection and Refraction.

When a ray of light impinges upon the surface of a gem, part of it passes through it, in accordance with well-known optical laws, and part of it is thrown back or *reflected*, in obedience to the following laws :—

(*a.*) The angle of reflection is equal to the angle of incidence.

(*b.*) Both the incident and the reflected ray are in the same plane, and this is perpendicular to the reflecting surface.

The amount of light thus reflected is different in different gems, and it varies also in proportion to the obliquity with which the incident ray falls upon the stone. The amount of light reflected increases up to a certain angle—differing in different stones; and under certain conditions *total reflection* takes place. To this property is due the superior brilliancy of the Diamond, as every incident ray which strikes a face, inside the stone, at a greater angle than 24° 13′ is totally reflected. We thus see the supreme importance of cutting a Diamond, not only of a graceful and handsome outline, but having each facet cut with such mathematical precision as to secure the greatest amount of reflection from its internal surfaces.

Leaving the reflected part of the ray, and passing on to notice that part which is transmitted through the gem, we find that this transmission is regulated by laws which may be thus enunciated :—

(*a*). A ray of light passing from a rarer into a denser

medium (as from air into a gem) is bent or *refracted towards* a line drawn perpendicular to the plane which divides them: and *vice versa.*

(*b*). The sines of the angles of incidence and refraction bear a constant relation to one another for each substance, which relation is known as its *refractive index* or *index of refraction.* It is to this property that lenses owe their magnifying power; the higher the indices, the higher the magnifying power. The *refractive index* of the Diamond is the highest of any well-known substance. It was the high refractive index of the Diamond that led Newton to suspect its composition, as explained at p. 57. Sir D. Brewster gives the following as the refractive indices (for the yellow ray) of several gem-stones compared with glass:—

Diamond	... 2·75	Chrysoberyl	... 1·76
Zircon ...	... 1·95	Spinel ...	1·75 to 1·81
Ruby ...	... 1.77	Crown Glass	... 1·5

An instrument called a *Reflectometer* has been introduced for the purpose of readily ascertaining the refractive index, and may be conveniently used in the examination of certain gem-stones.

Dispersion.

When a ray of common white light passes through a transparent medium, it may suffer decomposition, and be split up into its component colours. If the medium be properly shaped, this decomposition of the light is rendered evident, and in place of the white light which entered, there emerges a beautiful group of all the prismatic colours of the rainbow.

This act of splitting up is called the *Dispersion* of light. It is the phenomenon familiar to all in a chandelier drop. As might be anticipated, the dispersion is highest in the Diamond; in fact, the dispersive power of this stone is more than three times as great as that of rock crystal. It is upon this property that the matchless quality called "fire" in the Diamond depends. The lower the dispersive power, the less fire in the gem; the higher the dispersive power, the more brilliant and iridescent is the fire which it reflects from its surfaces. The dispersive power of certain kinds of glass or paste may be very high, but their softness renders them comparatively worthless for ornamental purposes.

Double Refraction.

The Diamond, Spinel, Garnet, and all other substances crystallizing in the Isometric or Cubic System, or those occurring in the amorphous condition, normally possess only *simple refraction*. The rest of the gems which crystallize in systems other than the cubic, are said to exhibit *double* refraction; that is to say, when a ray of light passes through them, it is split up into two rays, one of which—called the *ordinary* ray—follows the laws of refraction just described, while the other—called the *extraordinary* ray—follows a totally different law. This splitting or dividing of the ray depends upon the direction in which the light is transmitted through the gem; there being a certain position in which the ray suffers no division, and the substance simply acts as an ordinary medium, possessing single refraction; this direction is called *the axis of no refraction* or the *optic axis*. On looking at a small

bright flame through a transparent gem-stone, the flame will, if it be a simply refracting stone, appear single, and if a doubly refracting stone double. This is, however, a rough test; the stone must be moved from the eye till the effect is obtained; and the facets of a cut stone render the determination extremely difficult.

Polarization.

There is an important series of changes that light is subject to, known to physicists as *Polarization.* A full description of this phenomenon cannot be given here; but there are several interesting facts that may be mentioned.

When a ray of light falls upon a reflecting surface at a certain angle, and thence on to another similar surface, at a similar angle, it will be found that when the second surface is parallel to the first, the ray will be reflected from its surface; but when the position of the second surface is turned round so as to be vertical, the ray will no longer be reflected, and will therefore disappear. Under these conditions, the ray as it leaves the first surface is said to be *Polarized*; and the angle at which this is effected is called the *Polarizing angle.* This is different in different stones; for glass it is 54° 35′; for Quartz, 57° 32′; for Diamond, 68°—the angles being measured from a normal to the reflecting surface. To determine the polarizing angle of a gem, we have simply to reflect a ray of light from its surface at such an angle that it shall refuse to be reflected by a plate of glass inclined at 35° 25′ to the ray, when the plane of incidence is at right angles to the plane of reflection.

When a ray of light is split into two rays by its passage through a doubly refracting medium, the two are

polarized; and the well-known instrument, called a "Nicol's prism," conveniently enables the observer to obtain one of these polarized rays apart from the other,

Pleochroism.

Pleochroism is a term used to express the existence of a plurality of colours in one and the same stone, when viewed by transmitted light under certain conditions. This can be made an invaluable aid in the identification of certain gems, by the help of a little instrument invented many years ago, by the great Austrian mineralogist, Haidinger, and called the *Dichroiscope.* The mineral Iolite, takes its name of Dichroite from its marked dichroism. This mineral and some other stones, such as certain Sapphires and Tourmalines, may show the difference of tint to the unaided eye, but in most cases a special instrument is needed for its detection.

The dichroiscope is a very simple instrument, constructed as follows:—A cleavage rhombohedron of Iceland spar is fitted into a small metal cylinder, having at one end a sliding cap, perforated through its centre with an aperture, usually square. At the other end is a lens, or combination of lenses, of such focal length that when the sliding cap is pulled out, it will show, in consequence of the double refraction of the Iceland spar, two distinct images of the aperture. If a stone be introduced in front of the aperture, the two images will be of the same or of different hues, according to the optical characters of the stone. Those minerals with crystallize in the Cubic system such as Diamonds, Garnets, and Spinels, show a pair of images identical in colour. But all Precious Stones crystallizing in any of the other systems show, except when viewed in the direction of the optic axis, two images, the

colours of which differ to a greater or less extent. This property of exhibiting two colours is called *dichroism*, and the stone possessing it is said to be *dichroic*.

The following is a list of the principal gems which shew twin colours when seen with the dichroiscope, as given by Prof. Church, but slightly modified :—

NAME OF STONE.		TWIN COLOURS.		
Sapphire	(blue)	Greenish straw	and	Blue
Burma Ruby	(red)	Aurora red	„	Carmine red
Siam Ruby	(red)	Brownish red	„	Crimson
Emerald	(green)	Yellowish green	„	Bluish green
Beryl	(pale blue)	Sea green	„	Azure
Aquamarine	(sea green)	Straw white	„	Grey blue
Chrysoberyl	(yellow)	Golden brown	„	Greenish yellow
Tourmaline	(red)	Salmon	„	Rose pink
„	(green)	Pistachio green	„	Bluish green
„	(blue)	Greenish grey	„	Indigo blue
Peridot	(olive green)	Brown yellow	„	Sea green
Topaz	(sherry-yellow)	Straw yellow	„	Rose pink

Use of the Spectroscope.

This instrument, which is so familiar to the physicist, the chemist, and the astronomer, is not often used by the gem-expert ; but Prof. Church shewed, many years ago, that it might be usefully employed in the examination of certain stones. Thus, many transparent zircons, when viewed through the spectroscope, exhibit a characteristic series of black absorption-bands ; whilst another set of bands is shewn by most almandine-garnets.

APPENDIX B.

General Remarks Upon the term or word Carat, Rati, and Thola.

THE word Carat is derived from the name of a bean, the fruit of a species of *Erythima*, which grows in Africa. The tree which yields the fruit is called by the natives "Kuara" (Sun), and both blossom and fruit are of a golden colour. The bean or fruit when dried, is nearly always of the same weight, and thus in very remote time it was used in Shangallas, the chief market of Africa, as a standard of weight for gold. The Beans were afterwards imported into India, and were there used for weighing the Diamond.

The ounce weight (151½ *cts.*)
is used for weighing
Baroque Pearls, Coral
and Semi-Precious Stones.

The *Rati* is 89 per cent. of a carat; or, more precisely—

One Carat = 1·2280 Rati.
One Rati = 0·89062 Carat; and
One *Thola* is about 57 carats.

The Carat is not of the same weight in all countries, *e.g.*:—

England and her Colonies		=	205·4090	milligrams.
France	"	...	205·5000	"
Vienna	"	...	206·1300	"
Berlin	"	...	205·4400	"
Frankfort-on-Maine		...	205·7700	"
Leipzig & Amsterdam		...	205·0000	"
Lisbon	"	...	205·7500	"
Leghorn	"	...	215·9900	"
Florence	"	...	195·2000	"
Spain	"	...	105·3930	"
Borneo	"	..	105·0000	"
Madras	"	...	207·3533	"

INDEX

HOWLETT & SON, *Old Style Printers*, 10, FRITH STREET, SOHO, LONDON, W.

Extract from "*SOUTH AFRICA*," November 23rd, 1895.

. . . "English people 'who live at home at ease' appear to take great pleasure in creating suspicion of everything in the way of discoveries in which they have no hand. It was the same when diamonds were first discovered. In the first place, they did not believe that the stones shown were diamonds; and had not Mr. Streeter, of Bond Street, one of the highest authorities on precious stones, come to the rescue, there would, in all probability, have been no South African diamond industry during the present century. It was Mr. Streeter who satisfied the world that there were diamonds to be found in South Africa. He sent out a representative to purchase, who not only purchased, but bought claims and worked them; and so that matter was set at rest."

WORKS

BY

EDWIN W. STREETER,

Fellow of the Royal Geographical Society.

Member of the Anthropological Institute.

Gold Medallist of the Royal Order of Frederic.

Holder of a special Gold Medal from H.M. the King of the Belgians.

PRECIOUS STONES AND GEMS.

Demy 8vo. Richly Illustrated. Skin, 15/- ; Calf, 25/-. Sixth Edition, revised and partly re-written. An exhaustive and practical work for the merchant, connoisseur, or the private buyer. Treats upon every description of Precious Stones; giving their history, habitat, value and uses for Ornament; together with much information regarding their matrix or rough state, and where found.

CONDITION OF NATIONS.

By G. Fr. Kolb. Social and Political; with complete tables of Comparative Statistics. Translated, edited and collated to 1880. With Original Notes and Information by Edwin W. Streeter, F.R.G.S.

GOLD. (25th Edition).

Legal Regulations for the Standard of Gold in different countries of the world. Coloured Tables and Facsimiles of London and Birmingham Hall marks, Cloth.

THE GREAT DIAMONDS OF THE WORLD.

Their history and romance. Collected from official, private and other sources during many years of correspondence and enquiry. The MS. of the "Koh-i-Nur" graciously read and approved by HER MAJESTY THE QUEEN. The accounts of the "Pitt" and the "Eugenie" revised by HER MAJESTY THE EMPRESS EUGENIE.

PEARLS, AND PEARLING LIFE.

The only work published devoted to their history, both ancient and modern.

THE PEARL FISHERIES OF THE PERSIAN GULF.

Written at the request of the Government.

Pamphlet, 1889.

POCKET MANUAL OF PRECIOUS AND SEMI-PRECIOUS STONES, GEMS AND PEARLS.

Their composition, crystallization, hardness and specific gravity. Calf, 2/6.

GEORGE BELL & SONS, YORK ST., COVENT GARDEN.

PRECIOUS STONES AND GEMS.

By EDWIN W. STREETER, F.R.G.S., M.A.I.

London:—GEORGE BELL & SONS, York St., Covent Garden.

An exhaustive and practical work for the merchant, the connoisseur, or the private buyer. Treats upon every description of Precious and Semi-Precious Stones; giving their history, habitat, value, and uses for ornament: together with much information regarding their matrix or rough state.

Press Criticisms.

THE STANDARD.—"Mr. Streeter gives an accurate and complete description of every kind of Precious Stone and Gem known, and makes his book still more attractive and complete by a series of coloured plates of several stones in the rough."

THE DAILY TELEGRAPH.—"Considers the knowledge and experience of Mr. Streeter usefully displayed for the information of all."

THE DAILY NEWS.—"Few romances, indeed, can be more entertaining, though the primary object of the volume is strictly of a practical kind."

THE MORNING POST.—"Mr. Streeter prefaces his handsome volume with a warning to his readers that it is not intended as a scientific treatise, but a practical work on the nature, properties, and value of Precious Stones."

THE DAILY CHRONICLE.—"Mr. Streeter brings his wide experience to bear on the subject of Precious Stones. It is the combination of practical ideas with an artistic appreciation of the choicest gems that renders the work interesting."

THE MORNING ADVERTISER.—"This volume may be taken for the future as the text book of lapidarian lore."

THE PALL MALL GAZETTE.—"Contains a large amount of information lucidly stated. Of special significance to the admirer of jewels. At once instructive and entertaining."

THE ST. JAMES'S GAZETTE.—"There are several chapters in Mr. Streeter's book on South African, Australian, Brazilian, and Indian Diamonds; and as many more on coloured, the geological as well as the geographical regions in which they are found being clearly stated."

THE SATURDAY REVIEW.—"The valuable part of Mr. Streeter's book is that which relates to the diamond-producing countries."

THE GRAPHIC.—"As a manual of gems; their market price and characteristics. . . . . Mr. Streeter's book claims a speciality among the crowd of books about Precious Stones."

THE ILLUSTRATED LONDON NEWS.—"The antiquary not less than the naturalist will find a vast amount of curious anecdotes in this pleasant volume, which has been compiled with much diligent research."

THE OBSERVER.—"Mr. Streeter is to be congratulated upon having made his history and characteristics of gems exceedingly interesting, but also for having provided a manual of the greatest possible use."

THE QUEEN.—"The plan of this new book is so comprehensive that it includes very full details on many topics. The notes on coloured diamonds are very interesting."

THE ART JOURNAL.—One may read the book for pleasure and certainly for knowledge."

THE WORLD.—"Precious Stones and Gems" is written for the scientific collector of jewels, and contains many valuable hints."

THE TABLET.—"Mr. Streeter has met with great and well-deserved success in his work. It is the outcome of thirty-five years experience, and the author has spared no pains."

THE ILLUSTRATED SPORTING & DRAMATIC NEWS.—"A fascinating book, which, from end to end, affords unremitting pleasure."

THE COURT JOURNAL.—"The plan of the work is to give under the heading of each jewel its pecularities and characteristics."

THE EXAMINER.—"Mr. Streeter has handled his subject with a fulness, of knowledge which makes his book interesting to all."

PUBLIC OPINION.—"A book upon a special subject by an acknowledged master."

THE WHITEHALL REVIEW.—"Supplies a want which has long been felt. Of singular originality."

THE BULLIONIST.—"Is an authority of deserved weight and competence."

THE CITY PRESS.—"Details the interest and distinguishing characteristics of all precious stones."

THE LEEDS MERCURY.—"The work contains in a very attractive form, all that is known on the subject."

THE SCOTSMAN.—"Characterises 'Precious Stones and Gems' as an attempt to popularise information on the subject of which it treats."

THE UNITED SERVICE GAZETTE.—"Although the author does not claim to have written a scientific treatise, he has in reality done so."

THE NEWS OF THE WORLD.—"Considers it one of the most lucid and comprehensive expositions of the subject."

THE SUNDAY TIMES.—"Advises the reader, curious in such matters, to turn to a volume full of instruction and entertainment."

THE ARMY AND NAVY GAZETTE.—"It would be difficult to enumerate the mass of information."

THE GLASGOW HERALD.—Has never met with a book so satisfying on its particular topic."

THE NEW YORK TIMES.—"Mr. Streeter has just published a clever book on 'Precious Stones and Gems.'"

THE SUNDERLAND HERALD.—"This work is well calculated to create increased interest in the subject."

THE LIVERPOOL DAILY POST.—"It is the work of a recognized authority."

THE EDINBURGH COURANT.—"Mr. Streeter's subject loses nothing in his hands. He brings to his work both professional knowledge and literary ability."

YORK HERALD.—"A handsome volume . . . Useful alike in the library and drawing-room . . . Full of practical hints, research, and historical and descriptive tales."

THE

"CONDITION OF NATIONS,"

BY G. FR. KOLB.

SOCIAL AND POLITICAL, WITH COMPLETE TABLES OF COMPARATIVE STATISTICS.

Translated, edited, and collated to 1880. With Original Notes and Information by EDWIN W. STREETER, F.R.G.S., M.A.I.

Opinions of the Press.

THE STANDARD.—" . . . This book might be described, from one point of view, as a panorama of the internal condition of all the peoples of the civilized world, and from another, as a compendious and discreet decoction of the most important Blue Books of all the countries and all the languages which boast a literature of the kind . . . . We have before us some 950 closely printed pages, with all the fulness and fidelity that facts and figures can secure . . . No more thorough, comprehensive, or serviceable book of the kind has ever issued from the press."

THE ATHENÆUM.—" . . . . Deservedly holds a high place amongst works of its class. . . . It is a veritable treasury of statistical knowledge, and its historical retrospects and explanatory notes endow it with a permanent value."

THE DAILY TELEGRAPH.—" . . . . Time would fail us were we to try and make out a list of the different departments of life and action on which these statistics cast a new and bright light. . . . There are mines of information and guidance lying in the imposing volume before us."

THE DAILY NEWS.—" . . . . For this great work on Universal Statistics, statesmen and public writers, and indeed every student of political affairs, have good reason to be grateful . . "

THE ST. JAMES'S GAZETTE.—"Its pages replete to overflowing of facts excellently arranged . . . .

THE BULLIONIST.—"The work has been admirably rendered . . . . As a work of reference it will form a valuable work to any library."

THE STATIST.—"The work is carefully done, and will be found both interesting and useful to many."

THE ECONOMIST.—" . . . By far the most comprehensive volume we are acquainted with, as a general statistical description of the condition, both social and material, of every important nation of the world."

THE CITY PRESS.—"A valuable work of reference . . . . Scarcely a subject of any importance can be mentioned, which will not be found to have been treated at full length in this astonishing compilation."

THE FINANCIAL OPINION.—"No more comprehensive, or serviceable book has ever been issued."

THE ECHO.—"An immense variety of subjects have been passed under review with the most praiseworthy and painstaking industry, and most commendable attention to the simplest details of a great and exhaustive work . . .

THE UNITED SERVICE GAZETTE.—"It is not a mass of undigested figures, but a book teeming with wide and valuable information."

THE BRIGHTON GAZETTE.—"It is the best work on Sociology which has yet issued from the Press."

"GOLD."

By EDWIN W. STREETER,

Fellow of the Royal Geographical Society; Member of the Anthropological Institute
Gold Medallist of the Royal Order of Frederic;
Holder of a Gold Medal from H.M. the King of the Belgians.

Legal Regulations for the Standard of Gold in different countries of the world. Coloured map, plates, and tables. 25th Edition.

Opinions of the Press.

THE STANDARD.—"This book contains all the arguments which can be urged against what is called Government interference in determining the standard of gold."

THE MORNING ADVERTISER.—"In this volume, Mr. Streeter has given, in a concise form, valuable information about Hall Marks."

THE COURT JOURNAL.—"The general public cannot be supposed to understand the mysteries of carats and hall marks. Mr. Streeter's proposal that all articles containing less than 12 carat gold, or one half gold and one half common metal, should be sold as metal, is decidedly just."

THE PALL MALL GAZETTE.—"Mr. Streeter argues in favour of a warranty of the precious metals when used as articles of commerce."

THE BULLIONIST.—"This work has the double claim and attention due to the circumstance that it contains a valuable record of facts, and a clear argument in favour of a standard of purity for the precious metals."

THE QUEEN.—"The fashion of a bracelet, say of 9 or 12 carat gold, cost as much as the fashion of one of 18.

THE MORNING POST.—"Treats of the legal regulations of the precious metals in different countries.

"THE GREAT DIAMONDS OF THE WORLD,"

By EDWIN W. STREETER.

Fellow of the Royal Geographical Society; Member of the Anthropological Institute; Gold Medallists of the Royal Order of Frederic; Holder of a Gold Medal from H.M. the King of the Belgians.

Opinions of the Press.

DAILY NEWS.—"The present work aims at giving the history—the biography, so to speak—of each Diamond celebrated for its size or beauty, from the time when its original finder first became possessed of his fortunate discovery."

SATURDAY REVIEW.—"The present volume has been produced by the application of very considerable literary power."

ILLUSTRATED LONDON NEWS.—"We have by no means afforded an adequate review of Mr. Streeter's volume, but a mere sketch of the stories of a large proportion of the Diamonds described therein."

THE FIELD.—"It might be expected that things so much coveted would furnish many curious passages of history, and these Mr. Streeter has evidently taken much pains to collect."

DAILY CHRONICLE.—"For tragic romance and crime nothing in the world's annals can surpass what Mr. Streeter aptly calls 'the lurid history of the Diamond.'"

WHITEHALL REVIEW.—"It seems almost as though the diamonds themselves are telling their story."

THE GRAPHIC.—"Neither pains nor expense have been spared to make the record accurate and complete. . . . Mr. Streeter's work is probably the best extant upon this special work."

THE MINING JOURNAL.—"The amount of research necessary to produce a work of this kind must have been enormous."

THE UNITED SERVICE GAZETTE.—"Mr. Streeter has produced a most interesting and valuable record of celebrated jewels. . . . . The book is unique."

THE GLOBE.—"The amount of labour which has been expended on this book, would have almost served for the compilation of the history of the world, instead of merely that of its great Diamonds."

PICTORIAL WORLD.—"It is a monument of labour and careful research."

THE COURT JOURNAL.—"Mr. Streeter's work is full of the most romantic interest."

"PEARLS & PEARLING LIFE."

BY EDWIN W. STREETER,

Fellow of the Royal Geographical Society; Member of the Anthropological Institute;
Gold Medallist of the Royal Order of Frederic;
Holder of a Gold Medal from H.M. the King of the Belgians.

Opinions of the Press.

THE ILLUSTRATED LONDON NEWS.—"Mr. Streeter as everybody in London knows has the best possible reason for being learned about Pearls." Dec. 11th, 1886.

THE WORLD.—"Mr. Streeter is the author of 'Pearls and Pearling Life,' gives much curious information as to the pearling-grounds, the diving, and the treatment of the pearl." Dec. 13th, 1886.

THE ILLUSTRATED SPORTING AND DRAMATIC NEWS.—"The writer is versed in every detail of his subject." Dec. 18th, 1886.

THE COURT JOURNAL.—"This work tests that Mr. Streeter has the spirit of the explorer." Dec. 18th, 1886.

THE SUNDAY TIMES.—"Mr. Streeter has gone deep into the subject. The Illustrations have a recognizable value especially that of the pearl known as the Southern Cross." Dec. 19th, 1886.

THE DAILY TELEGRAPH.—"The account of the pearl fishing, is interesting. As a practical man Mr. Streeter thoroughly understands his subject." Dec 28th, 1886.

Z

THE MORNING POST—"Pearls and Pearling Life is interesting to such of the public as may wish to acquire a knowledge of the history and formation of the pearl." Dec. 25th, 1886.

VANITY FAIR.—"Mr. Streeter writes as a practical man and gives us facts and criticisms at first hand." Dec. 25th, 1886.

THE PICTORIAL WORLD.—"Mr. Streeter has a fleet engaged in pearl fishing in Sooloo Archipelago, off the coast of N.W. Australia." Dec. 30th, 1886.

THE ST. JAMES'S GAZETTE.—"With regard to Pearling Life the author gives an exhaustive account of the fisheries." Dec. 3rd, 1886.

THE GUARDIAN.—"In Pearls and Pearling Life Mr. Streeter gives the latest scientific theory of their production." Jan. 5th, 1887.

THE FIELD.—"Leaving his historical gatherings Mr. Streeter goes on to describe the various molluscs that are true Pearl bearers." Jan. 15th, 1887.

THE GRAPHIC.—"Mr. Streeter in Pearls and Pearling Life deals with the vexed question of their formation." Jan. 29th, 1887.

THE SPECTATOR.—"'Pearls and Pearling Life,' Mr. Streeter has a great deal to say as regards the pearl, both historically and commercially." June 18th, 1887.

THE QUEEN.—"The author who has a fleet of vessels engaged in the trade has had exceptional opportunities for acquiring information, and some of his facts are altogether remarkable." March 5th, 1887.

THE DAILY NEWS.—"In 'Pearls and Pearling Life' Mr. Streeter gives an interesting account of Pearls, their homes, their qualities, their beauties and their origin, and the manner of fishing for them." March 11th, 1887.

NATURE.—"It also treats with qualities which regulate the value of pearls." Feb. 10th, 1887.

THE CITY PRESS.—"This gentleman is generally considered as an authority." April 13th, 1887.

BROAD ARROW.—"Strange to say this is the first book which has been published entirely devoted to the pearl. May 21st, 1887.

TRUTH.—"Mr. Streeter's admirable monograph on 'Pearls and Pearling Life,' I can recommend strongly. August 4th, 1887.

THE TABLET.—"Few men in the world are able to speak with more authority on the subject of pearls than Mr. Streeter. July 30th, 1887.